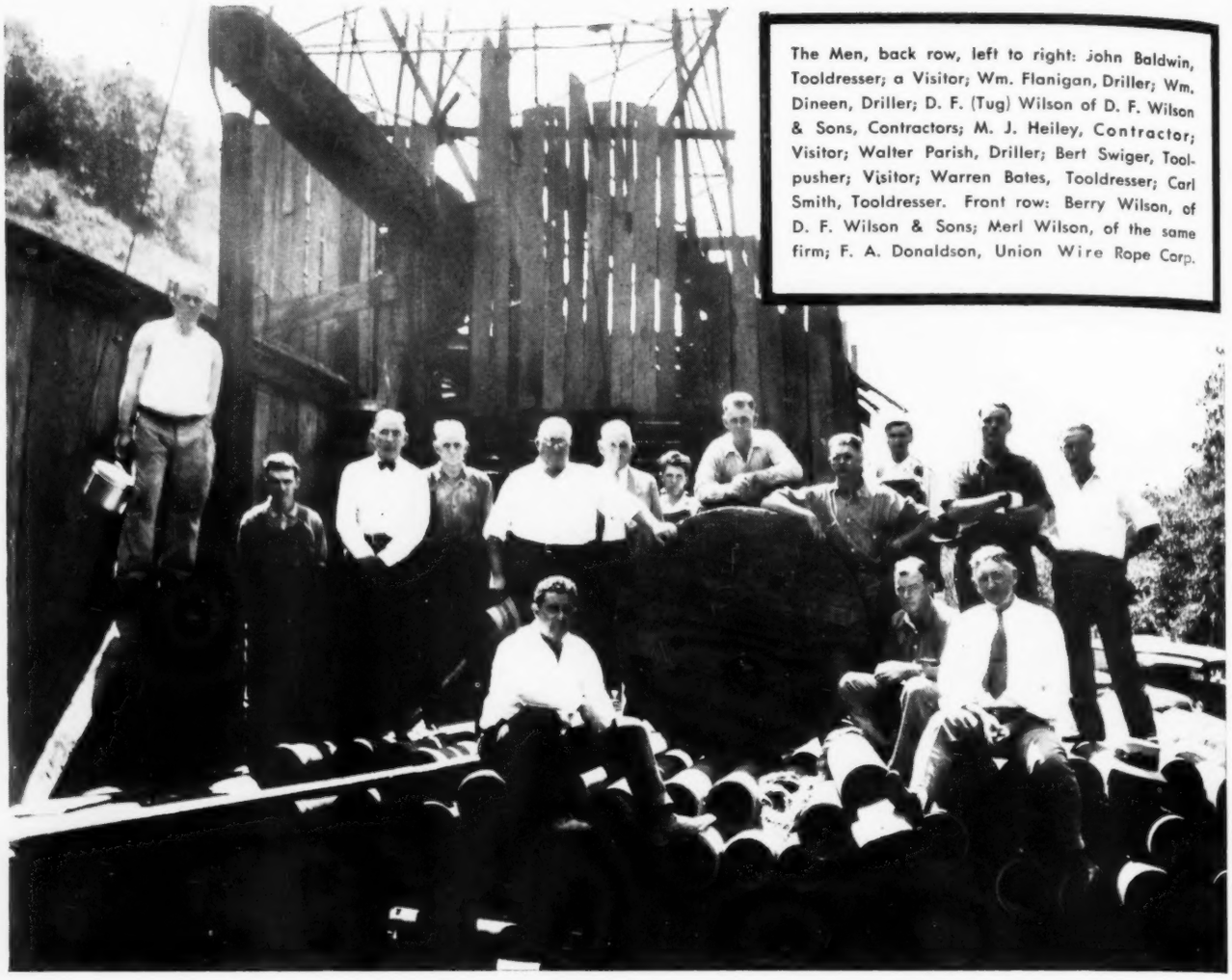
THE Petroleum Engineer

Tulsa, Okla. March, 1932

Oil Tanker At Sea

THE ENGINEERING MAGAZINE OF THE OIL AND GAS INDUSTRY



The Men, back row, left to right: John Baldwin, Tooldresser; a Visitor; Wm. Flanigan, Driller; Wm. Dineen, Driller; D. F. (Tug) Wilson of D. F. Wilson & Sons, Contractors; M. J. Heiley, Contractor; Visitor; Walter Parish, Driller; Bert Swiger, Toolpusher; Visitor; Warren Bates, Tooldresser; Carl Smith, Tooldresser. Front row: Berry Wilson, of D. F. Wilson & Sons; Merl Wilson, of the same firm; F. A. Donaldson, Union Wire Rope Corp.

"Young Blood" gets good training in the Selection of Wire Rope

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Shown above is the Warfield Gas Company well on the Kentland Coal Co. tract located at the boundary intersection of three states, Virginia, Kentucky and West Virginia. This is the second location for the UNION 7-8"x4000' Drilling Line in use.

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THE Petroleum Engineer

The Engineering Magazine of the Oil and Gas Industry

Edited and Circulated Only for those Actively Engaged in the Operating Departments of the Industry

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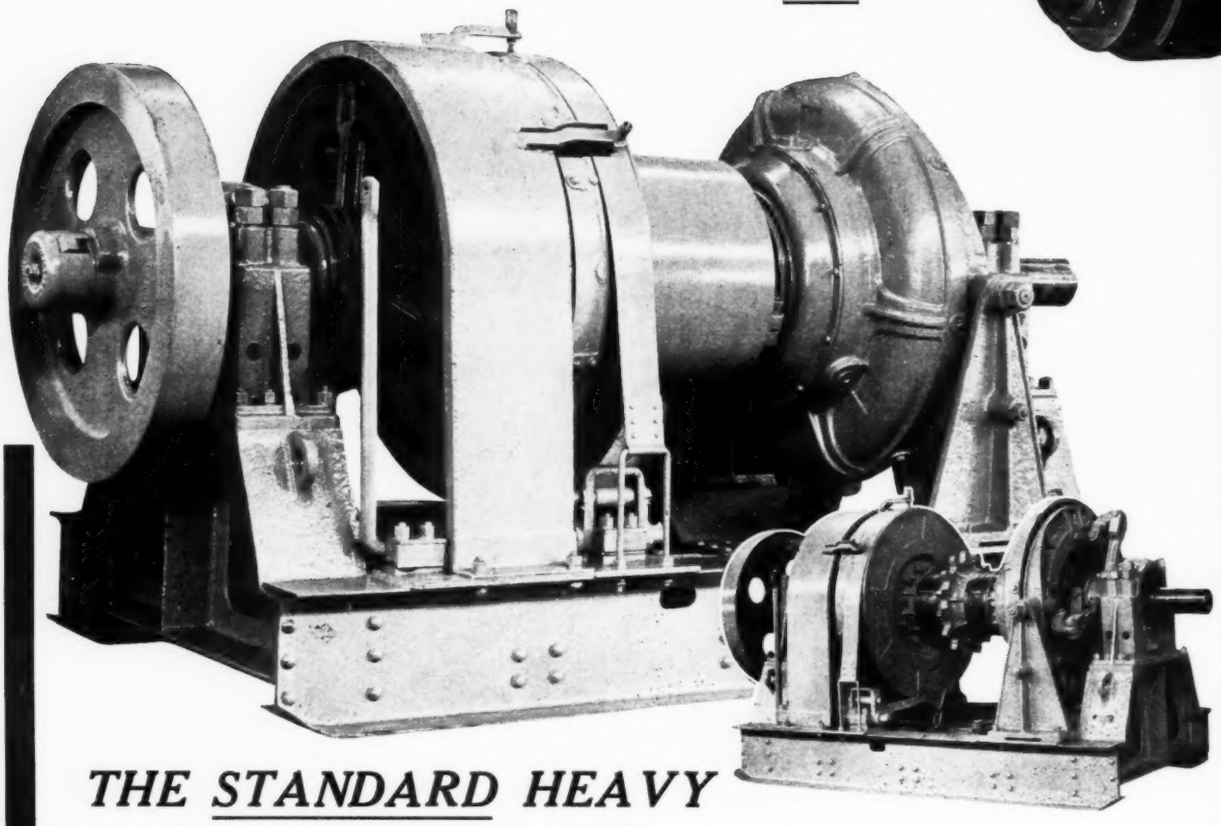
FOR REVERSE CLUTCHES, *too* . . .



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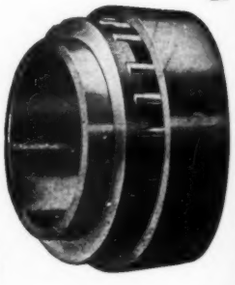
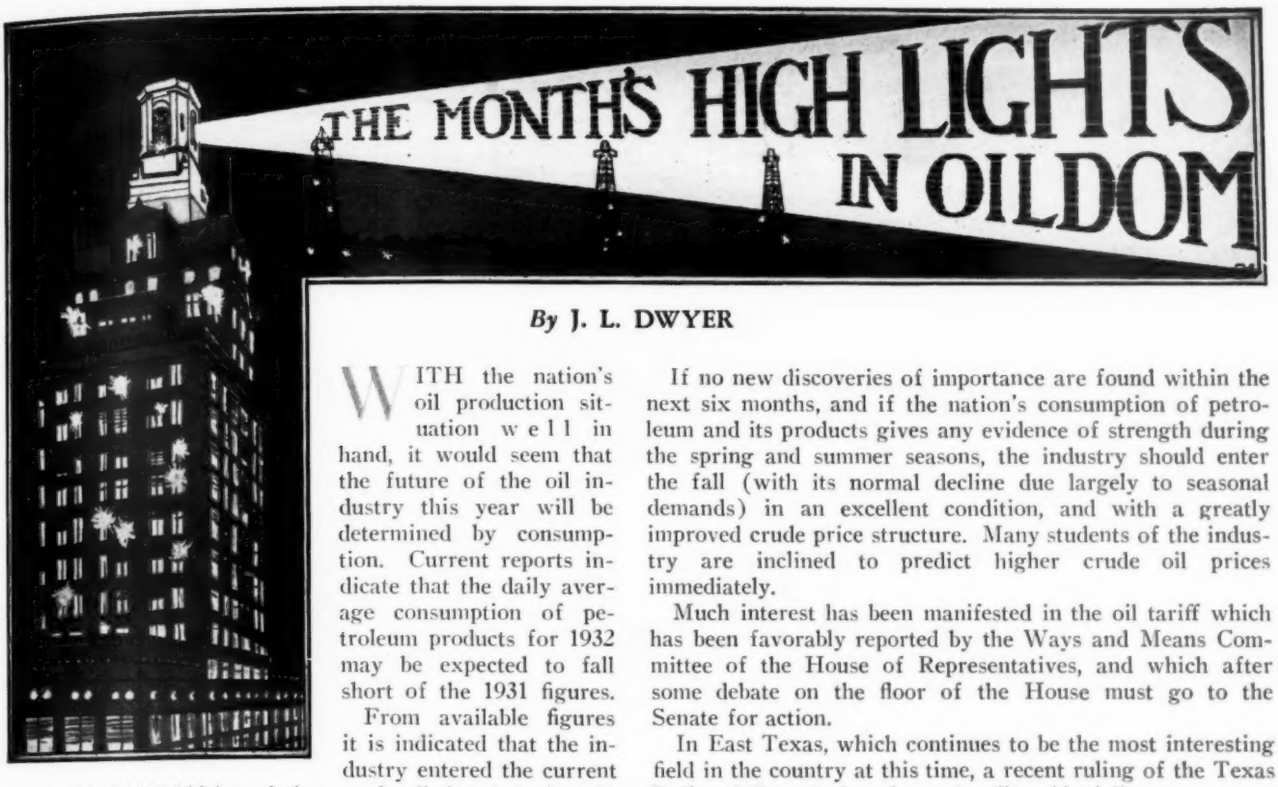




By **J. L. DWYER**

WITH the nation's oil production situation well in hand, it would seem that the future of the oil industry this year will be determined by consumption. Current reports indicate that the daily average consumption of petroleum products for 1932 may be expected to fall short of the 1931 figures.

From available figures it is indicated that the industry entered the current year with 46,000,000 barrels less crude oil than it had at the start of 1931. On January 1, 1932, the total stocks of the nation were 622,000,000 barrels, a figure which represents the lowest mark since 1922. During the year 1925, crude oil stocks above ground were almost double what they now are. For two months of last year we witnessed extraordinarily heavy draughts on stocks, approximately 28,000,000 barrels being withdrawn from stores during August and September.

Unquestionably the petroleum industry today stands in a good technical position. It should be considered, however, that the future in petroleum always presents possibilities which can overnight turn a healthy condition into chaos.

If no new discoveries of importance are found within the next six months, and if the nation's consumption of petroleum and its products gives any evidence of strength during the spring and summer seasons, the industry should enter the fall (with its normal decline due largely to seasonal demands) in an excellent condition, and with a greatly improved crude price structure. Many students of the industry are inclined to predict higher crude oil prices immediately.

Much interest has been manifested in the oil tariff which has been favorably reported by the Ways and Means Committee of the House of Representatives, and which after some debate on the floor of the House must go to the Senate for action.

In East Texas, which continues to be the most interesting field in the country at this time, a recent ruling of the Texas Railroad Commission places the allowable daily average production of the field at 325,000 barrels daily. At present there are 4,450 completed wells in the field which means that the average per well will be 73 barrels, a decrease of two barrels per well from the present allowable figure. The East Texas field has slightly less than 2,000,000 barrels of oil in storage at this time.

In the Texas Panhandle there has been some trouble over the problem of natural gas production. Waste has been charged in this area, and the Texas Railroad Commission has stated that the problem of gas in the Panhandle is one of the most perplexing which has ever confronted that body.

• • •

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending February 27, 1932
(Figures in barrels of 42 gallons each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Average Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Gasoline Stocks	Gas and Fuel Oil Stocks
East Coast	100.0	458,600	72.4	6,363,000	6,887,000
Appalachian	91.8	92,600	67.4	1,770,000	1,167,000
Ind., Ill., Ky.	98.9	261,700	60.6	5,760,000	4,678,000
Okla., Kan., Mo.	89.6	203,700	46.8	3,901,000	3,297,000
Texas	91.3	493,400	64.5	9,424,000	10,355,000
Louisiana-Arkansas	98.9	152,600	66.2	1,490,000	4,034,000
Rocky Mountain	89.4	38,300	26.6	1,999,000	693,000
California	97.1	441,800	49.7	14,860,000	96,125,000
Total Wk. Feb. 27	95.2	2,142,700	58.5	45,567,000	127,236,000
Total Wk. Feb. 20	95.2	2,190,400	59.8	43,792,000	127,209,000
Total Feb. 28, 1931	95.7	2,266,100	63.5	*44,092,000	†129,145,000
The Texas and Louisiana Gulf Coastal figures shown below are included above in the totals of their respective districts.					
Texas Gulf Coast	99.8	389,300	73.2	7,478,000	7,574,000
La. Gulf Coast	100.0	115,000	78.0	1,344,000	3,271,000

Daily Average Production
(Figures in Barrels)

	Feb. 27, 1932	Jan. 30, 1932	Feb. 28, 1931
Oklahoma	431,900	411,700	445,550
Kansas	100,250	97,900	113,100
Panhandle Texas	47,600	52,850	52,700
North Texas	47,300	49,350	58,700
West Central Texas	23,650	25,950	25,200
West Texas	178,750	173,750	243,550
East Central Texas	54,600	49,750	42,650
East Texas	304,750	332,750	33,900
Southwest Texas	51,200	52,100	76,600
North Louisiana	28,200	29,050	42,800
Arkansas	33,850	34,300	50,050
Coastal Texas	109,700	111,800	156,700
Coastal Louisiana	26,150	28,450	26,550
Eastern (not including Mich.)	101,700	106,600	103,300
Michigan	13,700	14,450	9,150
Wyoming	36,900	35,650	45,150
Montana	7,700	5,850	8,750
Colorado	3,600	3,650	4,400
New Mexico	37,350	37,000	39,800
California	499,200	508,600	522,300
Total	2,138,050	2,161,500	2,100,900

NOTE: Stocks at refineries, except in California district, which includes stocks of finished gasoline and engine distillate at refineries, water terminals and sales distributing stations and amounts in transit thereto.

• This figure is not entirely comparable with current stocks due to revisions made since original publication of this figure, for which revisions the basic information is not available by weeks. If it were possible to have made the revision, the new figure would reflect somewhat lower stocks.

† Figure of 129,145,000 barrels is comparable with previous weeks, but due to transfer in Texas Gulf Coast of 887,000 barrels from finished gas oil stocks to unfinished oils, the figure comparable with subsequent weeks is 128,258,000 barrels.

MANY RECORDS ESTABLISHED IN

By WARREN

NEVER before in history has the oil industry been so completely dominated by any one field as it was during 1931 by the East Texas oil field, comprised of the Joiner, Kilgore and Longview pools. In this great producing area have been established many remarkable developments and production records which are all the more amazing because the field is still in a stage of intensive development and is less than a year and a half old. The competitive drilling campaign throughout the territory did not begin until a year ago and the region but recently passed its first 15 months of producing history.

The first well in East Texas was completed by C. M. ("Dad") Joiner and associates seven miles northwest of Henderson, in Rusk County, in September, 1930. On December 28 of the same year the second pool in the district was discovered when Bateman and others completed a producer near Kilgore, nine miles north of the Joiner well. About this time considerable interest was aroused over the possibilities of a gigantic field, but it was not until one month later, January, 1931, that excitement reached a high pitch, when the Farrell, Moncrief and others' Lathrop well near Longview, Gregg County, 12 miles north of the Kilgore pool, was brought in.

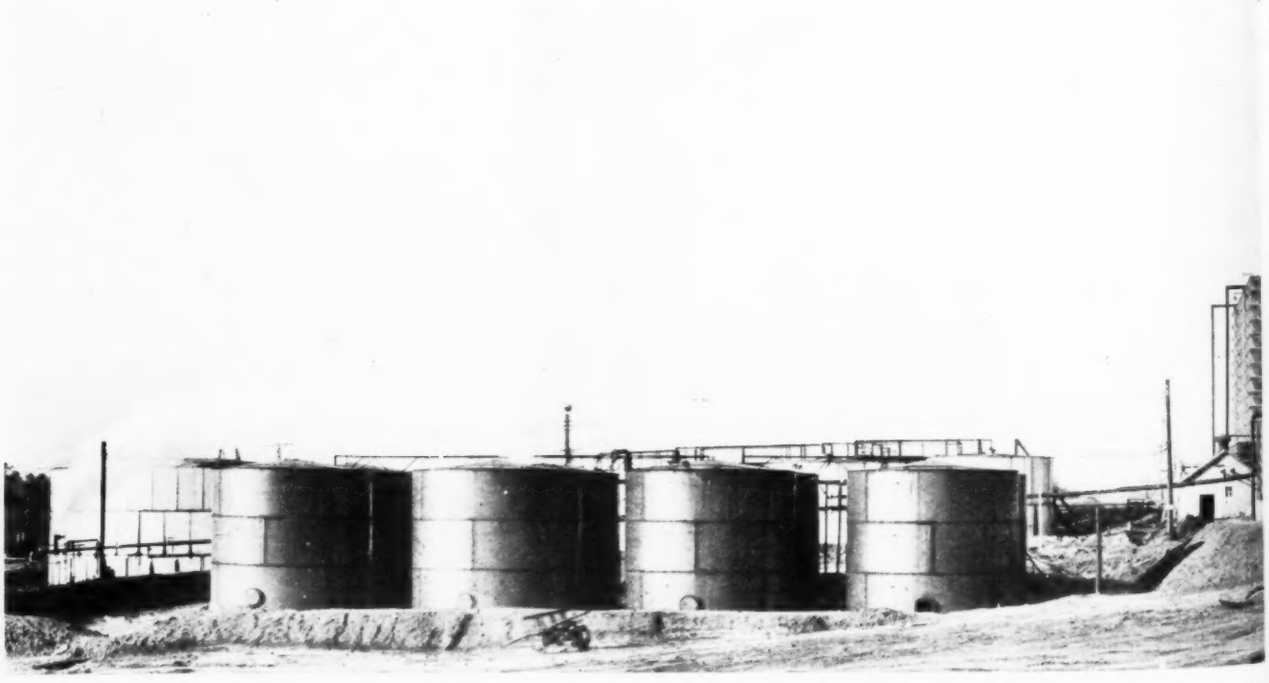
Since then more than 4,000 wells have been completed in the district, of which 3,636 wells were brought in during 1931. This figure represents more than one-fourth of the wells completed in the entire United States during that time. The period of greatest rapidity of development was during the last six months of the year, when 2,448 wells were completed. These wells gradually extended and subsequently connected the three producing areas until now the field is 50 miles long and ranges from three to ten miles in width, consisting of more than 100,000 acres of proven territory and spreading into Rusk, Gregg, Smith and Upshur counties. In one week, ending October 28, 1931, 172 wells were completed, and a week earlier 195 new locations were staked.

Orderly development has been difficult because of the diversified ownership and the many small acreage tracts. It is estimated that more than 600 concerns are in some way actively engaged in the oil business in East Texas. Conservative estimates are that the field will eventually have at least twice as many wells as at present.

Drilling in the district has been very, very simple. The 3,600-foot producing horizon is easily and quickly reached with rotary machines. In one case a well was drilled to the producing horizon in 72 hours and other wells have been completed in almost as rapid drilling time. The majority of rotaries used in the field are of a lighter type than the new, modern ones, and have been found adequate to perform all the work that is required of them in East Texas.

The contractors' price per foot for drilling has fallen rapidly as competition has grown more keen. In one instance a contractor bid but 65 cents per foot to a large operating company for drilling its wells, while the average price is $1.50 to $1.75 a foot. Drilling payments are frequently taken out in oil. It is interesting to compare these prices with $2.50 to $3.00 per foot prices which prevailed in the early history of the field.

An innovation of several of the small operators is the drilling of so-called "midget" wells. These wells, costing about $10,000, are drilled with a five-inch bit to the producing sand, after which a three-inch string of tubing is cemented into the hole. A string of 1¼-inch tubing is then placed in the well for a flow string. These wells are



East Texas Refining Company's Longview

IN EAST TEXAS FIELD . . .

L. BAKER

able to produce their allowable outlet and the operators hope to obtain their profit on the low investment by the time it is necessary to pump.

While many of the practices in the field are to be condemned as unsafe and undesirable, the necessity of operating with the utmost economy because of the price of oil and low allowable output per well, has brought about their adoption. Many of the practices are gambles to complete and produce wells with as little expense as is absolutely necessary. Many accidents to workers have resulted. In the long run many wells will be found decidedly hard to operate on a profitable basis.

The usual practice of bringing wells into production has been to use the "washing-in" method, whereby the hole is cleared of rotary mud by displacing it into the slush pond with clear water. Sometimes it has been necessary to swab the wells to get them to flow.

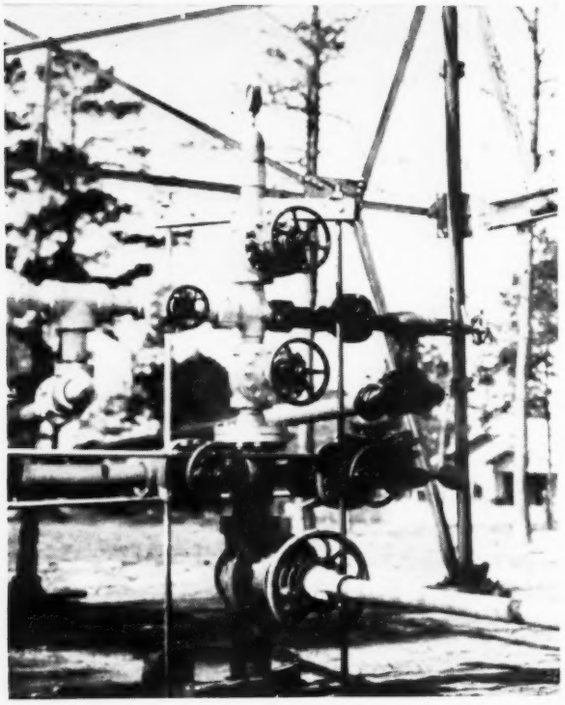
The field has produced more oil during its short history than any other area has produced in its first 15 months. During the year 1931 the area yielded 107,181,600 barrels of crude, or approximately one-eighth of the oil produced in the United States. The average daily recovery for the year was 295,000 barrels, and at one time—the week ending August 19—the field reached the amazingly high output of 848,350 barrels daily, a figure far exceeding the previous world's daily production record of 525,000 barrels established by the Greater Seminole, Oklahoma, field. Total recovery of production at the end of 1931 showed the Kilgore area leading with a yield of 43,350,500 barrels; next came the Joiner district with 37,575,750 barrels of oil, and the remainder, 26,255,350 barrels, was produced in the Longview area. Total initial production in East Texas from the 3,636 wells completed in 1931 was 28,000,000 barrels, or an average of 6,000 barrels per well.

The output of the field might have far exceeded these figures but for the enforcement of proration. The outlet of the field was curtailed from 225 barrels to 185 barrels per well on September 5, then at later dates to 165, 125 and 100 barrels, respectively, and is now 75 barrels per well. The enforcement of proration has been supervised by the Texas State Militia. The troops were first placed in the area on August 17, 1931, when Governor Sterling declared martial law as a means of enforcing curtailment of production and preventing undue wastage of natural resources. The field was completely shut in from this date until September 5, 1931, when it was allowed to produce 225 barrels per well.

Data on the field are quite incomplete because no one individual or company has sufficient personnel at hand to cope with the work of compiling records from the whole field. Thus far the recovery per acre has been from 1,000 to 45,000 barrels. The larger recovery has been where wells were the first completed in certain areas and producing before proration. Estimates on the ultimate yield vary from 8,000 to 20,000 barrels an acre, while the average sand thickness is estimated at 22.7 to 40 feet. Since proration many of the wells have not been drilled deep into the producing formation, as a small penetration permits the wells to make their allowable production.

Proration has been helpful in maintaining the pressure in the sand, which has prolonged the flowing life and retarded water encroachment from the west side. Conservation of gas and gas-pressure are very important producing problems, as the amount of gas is quite low in comparison with most oil fields. Some companies are using a tapered tubing string to maintain a low gas-oil ratio. The

plant, largest in East Texas.



Hook-up on a Tidal Oil Co. well, near Joinerville.

average gas-oil ratio for the field has been from 375 to 400 cubic feet a barrel. Other companies are choking their wells with good results in lowering the gas-oil ratio. Some of the gas produced is treated in the three natural gasoline plants located in the field (other plants are under construction), but much of it is used for firing boilers on drilling rigs.

Practically every well in the field is flowing through tubing, which is swung from some type of tubing support or head. Every known type of well christmas-tree connection is found in the field, but, speaking generally, these are quite simple and small. An elaborate casinghead hook-up has not been used because of the low casinghead pressures and the low allowable production of wells.

In many cases the derrick is dismantled and only the christmas tree is left over the well. Some companies (many using steel derricks) leave the derricks in place for future uses in pumping and pulling.

Although less than five per cent of the wells in the field are pumping at present, everyone agrees that the potential market for pumping equipment is tremendous.

In order to handle the vast flood of crude produced in East Texas it was necessary to lay hundreds of miles of new pipe lines. One of the most extensive networks of lines ever laid in a field was put down in East Texas. Total daily capacity of these lines, consisting of 17 main trunk lines, is three-quarters of a million barrels, although but a little over half that amount of oil is being run at present under the strict proration regulations.

Some of the operating companies could not obtain pipe line connections in the early development of the field, so loading racks were erected everywhere along the ample railroad facilities and several small refineries were built. A total of 53 loading racks were constructed and at one time almost 200,000 barrels of oil was moved daily by tank cars, but today approximately 1,200 barrels only is being moved in this manner.

East Texas has 18 refineries with a combined daily capacity of 90,000 barrels. These were all built in 1931 and comprise a new refinery construction record for any one area. The largest refiner of crude oil in the great field is the East Texas Refining Company, which has a modern 12,000-barrel plant at Longview. Equipment in this plant includes the two largest Horton spheroid tanks in the world, having 80,000 barrels combined capacity. This company also has a 6,000-barrel refinery near Henderson.

The price of crude oil in the area, which was $1.00 at the start of the year 1931, had dropped steadily to an average of 13 cents a barrel by August. Enforcement of curtailment regulations, which relieved the market of surplus crude, resulted in a gradual increase until the price reached 83 cents a barrel early in November, at which figure it now stands.

The discovery of so huge an oil field in East Texas brought many thousands of people into the area and the field soon became a miracle in growth, development and expansion. Housing facilities in the district were so inadequate that people slept on the streets, in cars, in the woods or any convenient spot. New frame houses, new stores and boarding houses were built as fast as lumber could be hauled in. The demand for housing space was so great it could not be met immediately. Tents and small frame shacks of all kinds were set up along all the roads.

Highways were traffic-bound and roads through the field became impassable due to rainy weather and heavy traffic. The area also received its heaviest rainfall in many, many years and frequently roads were closed to traffic. In many cases even wells were under water. Approximately 225 wells were shut down at the beginning of 1932, largely as a result of high water, which prevented getting equipment to the wells. At many wells water on the rig floor would not permit work. Those who, from absolute necessity, had to be in the field every day, soon learned to depend upon the old horse as the only reliable means of getting about. In some parts of the field boats have been used to good advantage in reaching certain wells.

A drilling well in the north end of the field.

Trends *in* Refining LUBRICATING OILS

By F. R. STALEY

Lube oil plant at Barnsdall refinery, Barnsdall, Okla.

DEVELOPMENTS in automobile design usually create new lubricating problems. Free-wheeling devices and gear teeth subject to extreme pressures require special grades of lubricants. Committee D-2 of the American Society for Testing Materials and the Lubricants Division of the Society of Automotive Engineers are jointly studying the requirements for these new lubricants. At the annual meeting[1] of the S. A. E. in Detroit classification for free-wheeling transmission lubricants was proposed, but formal adoption was postponed for further study.

Only viscosity and consistency are considered in the proposed classification. However, it is stipulated that these lubricants must be well-refined products, which do not contain any substance to build up artificial viscosity; nor are fillers or abrasives permissible.

Extreme-Pressure Lubricants

The lubrication of gear teeth with extreme-pressure lubricants has been investigated at the General Motors Research Laboratories. Mougey and Almen[2] pointed out that there is a large potential market for extreme-pressure lubricants, but until the oil industry generally is in a position to supply them, and until tests are developed to distinguish satisfactory products, such designs must be avoided. Among the various lubricants tested by these authors, lead-soap lubricants containing a large percentage of sulphur showed superior load-carrying ability. They indicated that it might be necessary for an oil to contain chemically active material to function as an extreme-pressure lubricant.

During recent years work has been carried on in a number of laboratories to improve the oiliness and lubricating qualities of motor oils. The addition of certain petroleum oxidation products has been developed in an Eastern laboratory.

A large Mid-Continent refinery[3] has successfully mar-

Proposed Classification for Free-Wheeling Transmission Lubricants

No. 110

For use in temperatures above 40 degrees F.

The viscosity of this lubricant at 210 degrees F. shall not be less than 140 seconds Saybolt Universal. The viscosity at 130 degrees F. shall not be greater than that given in the following table:

Max. Vis. at 130 Deg. F.	Vis. at 210 Deg. F.
1030	140
1100	150
1180	160
1250	170
1310	180
1360	190
1420	200
1480	210
1540	220
1590	230

This lubricant must not channel in service at +10 degrees F.

No. 90

For use in temperatures above 15 degrees F.

The viscosity of this lubricant at 210 degrees F. shall not be less than 74 seconds Saybolt Universal. The viscosity at 130 degrees F. shall not be greater than that given in the following table:

Max. Vis. at 130 Deg. F.	Vis. at 210 Deg. F.
345	74
355	76
370	78
380	80
390	82
400	84
415	86
425	88
440	90
450	92
460	94
470	96
485	98
495	100

The lubricant must not channel in service at 0 degrees F.

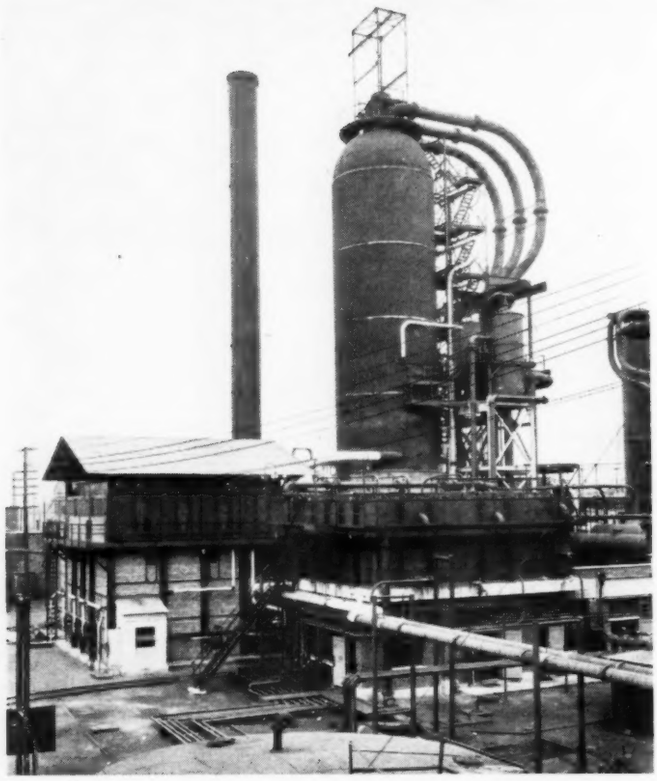
No. 80

For use in temperatures above —15 degrees F.

The viscosity of this lubricant at 210 degrees F. shall not be less than 42 seconds Saybolt Universal. The viscosity of the lubricant at 100 degrees F. shall not be greater than that given in the following table:

Max. Vis. at 100 Deg. F.	Vis. at 210 Deg. F.
168	42
180	43
190	44
203	45
215	46
227	47
239	48
251	49
263	50
275	51
287	52
299	53
311	54

The lubricant must not channel in service at —10 degrees F.



Vacuum distillation unit running 10,000 barrels of reduced crude daily to overhead cylinder stock.

keted a line of motor oils compounded with sodium oleate; the demand for these oils is constantly growing.

Refining Practice

Present-day lubricating oils are generally refined from selected crudes. Many improvements in refining methods have been adopted. Perhaps the most important development is highly efficient distillation units consisting of a pipe still equipped fractionating columns operating under atmospheric pressure or high vacuum. They produce very close-cut fractions from the crude.

Lubricating distillates from mixed base crudes are treated with sulphuric acid to improve the color and carbon residue. Continuous treating methods and the removal of all the sludge particles by centrifuging or filter pressing reduced filtering and decolorizing costs.

Methods of contact filtration have been improved. Much new knowledge on treating fine clays has been obtained. A number of Mid-Continent refineries have acquired excellent clay deposits in this area and are no longer required to use California clays. Consequently, considerable savings in freight costs result. Reduction in clay costs has eliminated the necessity of revivification.

Bright stocks and long residuum are now generally dehydrated in vacuum towers[4] instead of blowing bright with air, which caused the oil to darken. The oil is brightened by percolating through a shallow bed of Fuller's earth in some plants.

Paraflow

Many refineries are now using a small percentage of Paraflow[5] in their motor oils to lower the pour point rather than completely dewaxing them. This is a pure hydrocarbon lubricant manufactured by the Standard Oil Development Company. By its use it is possible to obtain a low pour point without impairing the desirable characteristic of the oil.

Typical Inspection of "Paraflow"

Gravity, deg. A. P. I.	23.8
Viscosity* at 100 deg. F.	3,612
Viscosity* at 210 deg. F.	214
Viscosity Index	106
Pour point, deg. F.	25
Flash point, deg. F.	555
Conradson carbon	1.00
Color (Robinson)	¼
Cast	Green

*By Saybolt Universal viscosimeter.

The addition of ¼ to 1½ per cent of Paraflow to paraffin base oils reduces the pour point from around 30 degrees F. to below 0 degree F.

Synthetic Oils

The Standard Oil Company of Indiana operates a plant at Whiting for manufacturing synthetic lubricating oils.[6] Paraffins are cracked and the resulting olefins are polymerized with aluminum chloride. The finished oils are superior to those occurring in crude oil. They possess a high flash, high gravity, high viscosity index, excellent color, and a low pour test, being wax-free. They are highly stable to oxidation. These properties make them suitable for certain applications requiring exceptional lubricants.

In the development of the process cracked distillates from various charging stocks were polymerized, and it was found that the more paraffinic the charging stock, the better is the temperature coefficient of viscosity of the synthetic oil; in the case of wax-bearing stocks, the higher the wax content, the better the quality of the oil. The oil produced from refined wax possesses a lower temperature coefficient of viscosity, a higher gravity and a lower pour test than oil from any known crude.

Hydrogenation

Steady progress has been made in the hydrogenation of petroleum. The Standard Oil Company of New Jersey operates three commercial plants in this country. One of the adaptations of hydrogenation is the alteration of low-grade lubricating distillates to obtain high yields of lubricating oils of premium quality as to temperature-viscosity relationship, carbon residue, flash and gravity. By hydrogenation excellent lubricating oils are produced from inferior lubricating distillates. Hydrogenation at present is supplementary to present refining methods and will supplant them as the supply of crude oil and the demand for light products approach a balance.[7]

Chemical and engineering research has not only provided the refiner with methods and equipment for the most economical separation of the highest quality lubricating oil from a crude oil, but they have made available commercial methods of manufacturing synthetic lubricating oils which possess qualities superior to the natural refined oils. Although these latter methods are still in their infancy their importance will no doubt steadily increase.

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Redesign *of* Diesel Fuel Supply Lines Eliminates Paraffin Troubles

By J. H. DAMERON

PARAFFIN trouble resulting from handling East Texas crude oil is not confined to choking up lines and restricting flow. Most of the stations located in that area are experiencing some trouble with machinery because of the quick-congealing crude. The degree of trouble depends largely upon the crude being run. Crude produced from some sections of the field causes more trouble than crude produced in other sections.

In the oil engine stations the greatest trouble is with the fuel lines and fuel pumps. Paraffin clogs the lines or prevents proper functioning of the valves in the fuel pumps. In some instances the fuel oil in the overhead cone-bottom fuel working tanks has congealed and permitted water to pocket in the fuel oil and this water later found its way to the fuel pump and caused the engine to shut down. Operators at several stations find it difficult to keep the drain lines from their pumping units open because the oil coming from the glands around the pump congeal and clog those lines.

Where East Texas crude is used as fuel oil and the mechanical departments have experienced considerable trouble in keeping the fuel lines open and the fuel pumps working properly several methods of heating the oil have been worked out with success. Because the oil starts vaporizing at about 100 degrees F., the temperature is kept about blood heat to prevent vapor lock in the fuel pump, when fuel is heated in an overhead tank.

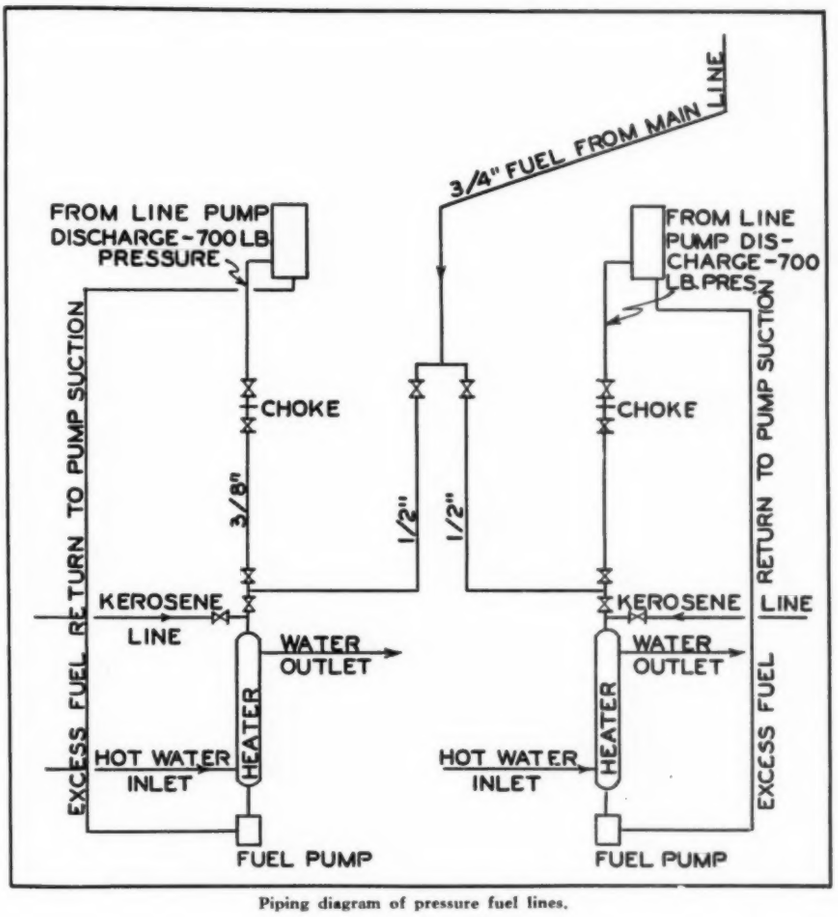
The problem of preventing the fuel from congealing and reducing the accumulation of paraffin in the fuel lines and pump presented itself in a serious way to one company handling crude from the Lathrop area. The two initial stations were Diesel powered plants using the crude as fuel and both stations were operated with closed circulating water systems.

Both station A and B used crude oil as fuel and both had cone-bottom tanks to permit draining off sediment and water. At station B the operator switched fuel tanks after draining off the water and b.s. in the fuel tank, early one chilly morning. About an hour later the engine started mis-firing, sputtered a few times and shut down. Before the operator could notify station A of the trouble and switch necessary gates, the line pressure mounted and burst some connections on the closed water system which used the incoming stream of crude as a cooling medium for the jacket water.

An investigation revealed that a pocket of water was slugged through the fuel line and caused the unit to shut down. Further investigation showed the fuel in the working tank congealing in layers which permitted small pockets of water to accumulate. One of these pockets of water was drawn into the fuel line and the slug was sufficient to cause the engine to "die".

With the idea of obtaining a full supply of fuel at all times and preventing the accumulation of paraffin in the lines, the Prairie Pipe Line Co., at its Meredeth station in Texas, has its fuel system hooked up to the station's discharge manifold, for use during extreme weather. During mild weather the system is tied into the suction line. This, in connection with the use of a small heater set ahead of the fuel pump, has eliminated trouble with the fuel lines during the mild weather of the current winter.

It is practice at this and other stations on the line to start up and shut down on kerosene on cold or chilly days. The kerosene line is tied into the fuel system just ahead of the small heater. The latter was made small so that it would heat quickly. When starting on kerosene the engine is run long enough to get the exhaust tees hot. The hot water is then turned into the small heater which puts it



Piping diagram of pressure fuel lines.

at a temperature of 120 degrees. The kerosene is heated by the heater and as the fuel pump warms the deposit of paraffin in the pump and fuel lines is dissolved by the warm kerosene.

Usually the engine is run about 30 minutes on kerosene before it is cut off and the fuel pump switched to fuel oil. The operator usually continues to use the hot water heater to warm the fuel for a short while after switching over to crude as fuel.

During the early operation of these stations with East Texas crude as fuel, it sometimes required a day's time to get a unit running. During such times the fuel lines were broken and hot water run through the fuel pump to remove the congealed crude in the valves and lines. So badly clogged were the lines and pump that the cold kerosene could not be gotten through the pump.

Because of this condition it is practice to shut down the units with kerosene. About 30 minutes before a unit is to be shut down the crude oil fuel is cut off and the kerosene line opened. At the same time hot water is circulated through the heater and the hot kerosene going through the fuel pump and fuel lines removes any paraffin and congealed oil which might have collected there during the run of the engine. By operating thusly the fuel pump and lines are filled with kerosene when the engine goes down and the unit is ready for starting again.

This method of handling the fuel oil eliminates the use of an overhead fuel tank where the oil would congeal when its temperature dropped to about 48 degrees. With the return of warm weather the fuel will be handled through the overhead tanks. The present system brings the oil direct from the incoming line or from the tank suction line. It comes in at a low pressure through a three-quarter-inch line and goes direct to the fuel pump. Any surplus crude at the fuel pump is returned to the main pump suction manifold.

For extreme weather, however, a three-eighths-inch line is connected to the discharge manifold of the line pumps. The line from each pump is equipped with a choke or an orifice plate located on the pump room side of the station. This reduces the pressure down from 700 pounds and permits about 70 gallons of oil to flow into the fuel line per hour. Any excess crude is returned to the pump suction.

While the weather has not been cold enough to warrant the use of the high pressure fuel system, it is believed no trouble will be experienced during the coldest weather. The high pressure is expected to keep the orifice open and the turbulence of the fluid should prevent the oil from congealing during its short travel to the fuel oil heater.

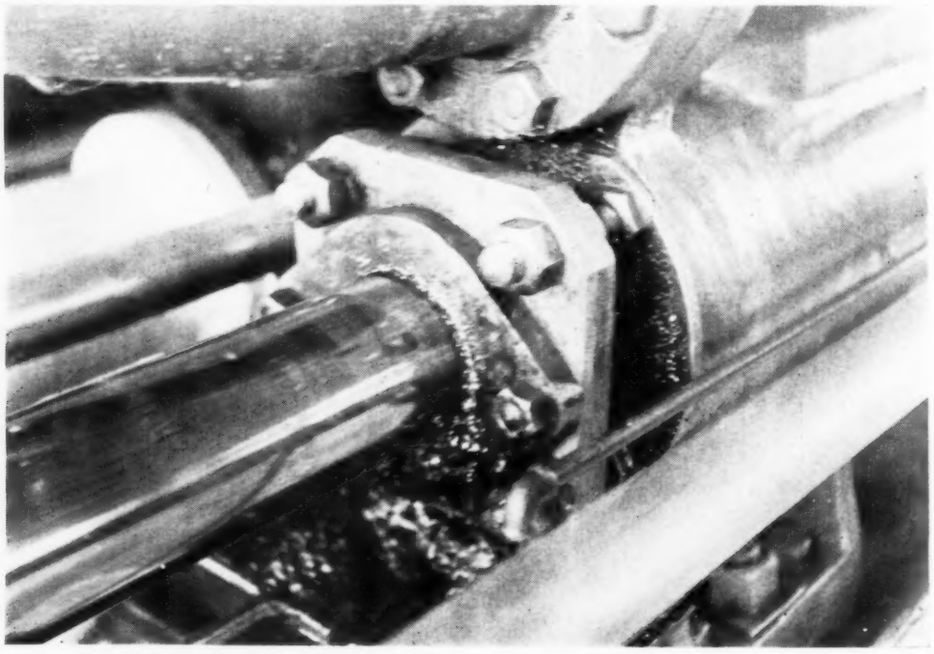
The small heaters were made with three-foot lengths of four-inch pipe and the tubes are comprised of nine feet of three-quarter-inch pipe.

Since this method of handling the fuel for the two 400 horsepower engines was started late in December, the stations have had no trouble resulting from clogged fuel pumps or lines. The warm kerosene apparently cuts the paraffin from the pump and lines and by shutting down on kerosene no trouble has been experienced in starting the units. Such a system is economical to build and more than pays for itself in the saving of down time.

Clogged drain lines are another necessary evil incident to pumping the East Texas crude. The oil escaping around the packing glands on the pumps congeals in a jelly mass in the drain. Some of it congeals in the drain line, but most of it congeals around the drain opening. In some cases this has resulted in the crude filling the drain pan, backing up and spilling into gear cases, contaminating the gear grease. Where hot water connections are available some operators flush their drain lines with hot water. Others keep the drains open with various types of swabs.

Some of the companies have been so greatly troubled with paraffin deposits in their main lines that it is necessary to run a scraper frequently in order to pump close to capacity. This often results in the strainers filling rapidly with paraffin and sometimes the paraffin gets on into the pumps to lower their efficiency.

In order to insure all crude going to the pumps being passed through a strainer, many companies have a double strainer located on the incoming line. When one strainer is loaded the valve is turned, shutting off the stream going to the loaded strainer and at the same time opening the line to the clean strainer. While the clean strainer is in service, the loaded one is removed and cleaned.

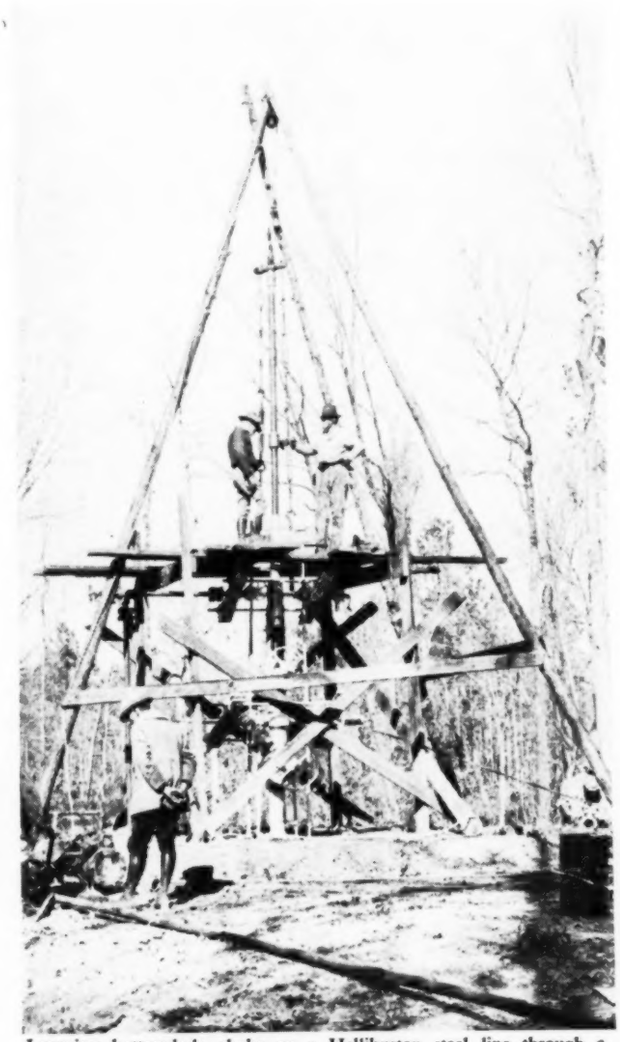


Detailed view showing congealed crude around packing gland on pump.

Freezing Troubles *at* Gas Wells Eliminated *by* Bottom-Hole Chokes

By K. C. SCLATER

CONTROLLING gas wells of high pressure and large volume to obtain small daily withdrawals of gas is usually difficult and also exceedingly dangerous. A large pressure reduction at the surface results in low temperature and subsequent trouble therefrom by freezing of the well controls. To overcome this difficulty, heaters of various types have been designed, but these, at best, are only expedients, and their operation is uncertain and expensive. They must be installed at a safe distance from the well. As the full working pressure of the well is usually carried to a point beyond the heater, all surface connections up to this point are under high pressure. Variations in the rate of withdrawal of gas from the well, in the pressure of the gas to the heater flame, and in the surface temperature, all combine to affect the efficiency of the heater. In extreme conditions, failure of the heater for only a few minutes means freezing of the controls, shutting off the gas flow, interrupting the supply of gas to the pipe line and—most feared of all—subjecting all surface connections, through the heater to the point of pressure regulation, to the full closed-in pressure of the well. Another objectionable feature is that the extremely low temperature may result in subjecting these connections to strains equal to, if not greater than, those resulting from high pressure alone. Men in charge of a gas well's operation always dread the responsibility of keeping a heater working efficiently during a cold spell.



Lowering bottom-hole choke on a Halliburton steel line through a lubricator into the well.

Just such extreme conditions of operation are found in the Trinity zone wells in the Rodessa, Louisiana, gas field. Approximately 5,600 feet deep, these wells have a closed-in pressure at the surface of 2,340 pounds, a large open-flow capacity, and a high gasoline content. Though all, except the discovery well, are equipped with two-inch tubing, a daily withdrawal of two and one-half million cubic feet has been found necessary in order to remove the gasoline from the well continuously in such manner as not to interfere with accurate metering of the gas. A double installation of heaters of the most approved type was made at these wells before attempting to put them on the line, but despite this careful preparation, it was impossible to feed the wells into the line safely and satisfactorily at low rates of flow. This was not all. From three to ten hours would be consumed in placing the well on the line, and during all this time it was necessary to keep several men at the well. Even after everything was regulated, a watchman was posted at the well day and night to make certain that the heater was kept in proper operation. Failure of the heater for but a few minutes meant the sudden and complete freezing up of the controls.

This difficulty has been overcome simply and effectively by the use of removable bottom-hole chokes. Heaters have been eliminated entirely and the surface tubing connections, instead of operating under pressures in excess of 2,300 pounds, now operate at a pressure of only about 300 pounds. Turning a well into the line no longer is the formidable job it used to be, requiring several hours with a crew of men, instead, it is now a five-minute job for one man, a job that is now free from the apprehension that once attended it. This is because of the hazards, both to the men and to the well itself, having been practically eliminated. Such advantages and the part they play in obtaining greater economy of operation are obvious.

Bottom-hole choking moves the point of pressure reduction—and consequently of refrigeration—from the surface to the bottom of the well where the temperature is high enough to preclude the possibility of freezing regardless of how restricted the rate of production may be. The flow velocity of small quantities of gas under high pressure through tubing is relatively low, allowing ample time for heat exchange between this gas and the gas surrounding the tubing on the outside. Consequently, the normal delivery temperature of gas withdrawn at low daily rates of flow, before the pressure is reduced, is that of the gas in the upper part of the casing,

About ready to run the choke. Equalizing the pressure in the lubricator before opening gate valve on tubing.

or about the mean temperature of the region in which the well is located. In the Rodessa field, this temperature is about 60 degrees F.

At this temperature, the quantity of latent heat in the gas is insufficient to prevent freezing when the gas is expanded at the surface controls and it was necessary to provide additional heat to the gas by means of heaters before reduction of pressure.

With bottom-hole chokes, however, the gas enters the choke at the bottom-hole temperature of the well, a temperature usually very much higher than the mean temperature at the surface. In the gas wells in the Rodessa field, the bottom-hole temperature is about 200 degrees F. At this temperature, there is sufficient latent heat in the gas to prevent freezing as it expands after passing through the choke. Another factor in bottom-hole choking that removes still further the possibility of freezing, is the presence of the high-temperature gas surrounding the tubing for some distance above the choke. The cooling effect is dissipated by a transfer of heat from this gas to the cooled gas in the tubing. By virtue of this heat transfer the refrigerating effect due to expansion is greatly diminished. It is this action that tends to raise the temperature of the expanded gas back to the bottom-hole temperature. However, the gas above the choke having been expanded to a comparatively low pressure, its volume and flow velocity are increased, hence there is less opportunity for the gas on its way to the surface, to regain some of the heat lost in expansion through the choke.

When choking at the bottom of the well to a pressure of about 600 pounds on the downstream side of the choke, the delivery temperature of the gas in the wells of the Rodessa field actually is ten degrees F. warmer than the surface delivery temperature (that is, before reducing the pressure) of the gas delivered prior to the use of bottom-hole chokes.

The bottom-hole chokes in these wells at Rodessa are operated beyond the pressures necessary for a critical flow velocity; that is, the pressure on the downstream side of the choke is less than half the pressure on the upstream side of the choke. So long as the pressure on the downstream side of the choke remains less than half the pressure on the upstream side practically no variation in the rate of withdrawal of gas can be obtained. The volume of gas passing through the bean under such conditions remains almost constant. If it is desired to vary the rate of withdrawal through the tubing the rate of flow through the choke must be less than the critical velocity, or, stated in terms of pressure, the pressure on the downstream side of the choke must be greater than one-half the pressure on the upstream side of the choke. In the case of the gas wells at Rodessa, this means that the surface delivery pressure would have to be raised to about 1,100 pounds before a reduction in the rate of flow could be obtained. At this pressure freezing up of the controls at the surface would occur.

A variation in the rate of withdrawal is not required in these wells at this time, but tests now under way indicate that an adequate variation in delivery rate can be obtained by withdrawing gas from the casing in addition to that taken through the tubing. Gas taken from the casing must be reduced over the same pressure range that formerly was necessary for gas taken from the tubing, and the same freezing problems again arise. It has been found, however, by tests made under extreme conditions of pressure reduction that the cold gas from the casing, mixed with equal quantities of warm gas from the tubing (see accompanying sketch), gives a mixed gas that is well above freezing temperature. Under less extreme conditions of pressure drop, it is probable that a still greater proportion of casing gas can be mixed with warm tubing gas without encountering freezing trouble. Thus, by inserting a bottom-hole choke that will pass the estimated minimum rate of delivery, and using the warm low-pressure gas thus delivered to heat the colder gas taken as needed from the casing, a greater range of control for varying the rate of withdrawal is obtained.

All the wells in the Rodessa field, except one not yet tubed, have been equipped with removable bottom-hole chokes. The chokes were run in the wells under pressure on a steel line, and set at a point about 75 feet above the bottom of the tubing. No difficulties were encountered other than those occasioned by heavy, steady downpours of rain, a not infrequent occurrence in this part of the country. The entire installation of chokes was made by the Southern States Company of Shreveport, under the supervision of H. C. Otis, who has pioneered the development, method of installation, and use of removable bottom-hole chokes.

On checking the capacities of beans of different diameter, it was found that on test, these checked very closely with the values given in the various handbooks on natural gas. If the bottom-hole pressure is known, it is a simple matter to compute the proper size bean for any desired rate of flow. At the working pressures encountered in the Rodessa wells, a 13/64-inch bean will deliver 400,000 cubic feet more gas daily than a 12/64-inch bean at the same depth. This illustrates the extreme sensitivity of the gas volume to changes in bean diameter at these high pressures.

Among the wells in this field there is a wide range in open-flow capacity from a few million cubic feet, to more than 75 million cubic feet of gas daily. With such differences in capacity it seemed that if each well were to be made to produce an equal daily volume of gas, regardless of its open-flow capacity, it would be necessary to install a bean of different diameter in each well. Such was not the case, however, for it was found that a 12/64-inch bean in a well of 20-million cubic feet open-flow capacity produced almost the same volume of gas as the same diameter bean, at the same depth, in a well of 75 million cubic feet open-flow capacity. This, of course, could be attributed to a high bottom-hole working pressure, by reason of which a sufficient pressure differential was set up between the upstream and downstream sides of the choke to maintain a critical flow velocity through the bean. The slow rate of gas withdrawal from the well probably was not sufficient to reduce the bottom-hole working pressure very much below the bottom-hole closed-in pressure of the well. Also the fact that the wells were only on continuous production for a few days at a time would assist in maintaining a high pressure in the gas sand in the vicinity of the well and thus help maintain a high bottom-hole pressure.

From the results obtained in the Rodessa field there is

good reason to believe that it is within the realm of practicability to operate extremely high pressure gas wells of large volume, at low rates of delivery, without resorting to heaters and without having to hold surface fittings continuously under dangerously high pressures.

Controlling flow at the bottom of the hole by means of chokes is applicable to almost any type of gas well. If large quantities of liquid are produced with the gas, trouble from freezing is usually greatly aggravated. It may also necessitate blowing the well off at frequent intervals. This means opening the well to the atmosphere, admittedly bad and dangerous practice. Irreparable damage to the well may result and, almost without exception, large volumes of gas are dissipated.

A gas well in the Holdenville area, Oklahoma, was brought in November, 1930, with an open-flow capacity of about nine million cubic feet and an initial closed-in surface pressure of 980 pounds. The total depth of the well, which has 2,952 feet of 8¼-inch casing, is 3,020 feet.

During the winter of 1930-31, considerable trouble occurred at this well owing to freezing of the surface controls, caused chiefly by gasoline and traces of oil coming out with the gas from the siphon line (1¼-inch tubing) through which the well was being produced. When the trouble became acute, the well was produced through the casing, the siphon line being used only to keep the well clean and free of liquid by blowing off at intervals. A spider-type regulator with 1-inch piping and valves was used to control the rate of flow from the well.

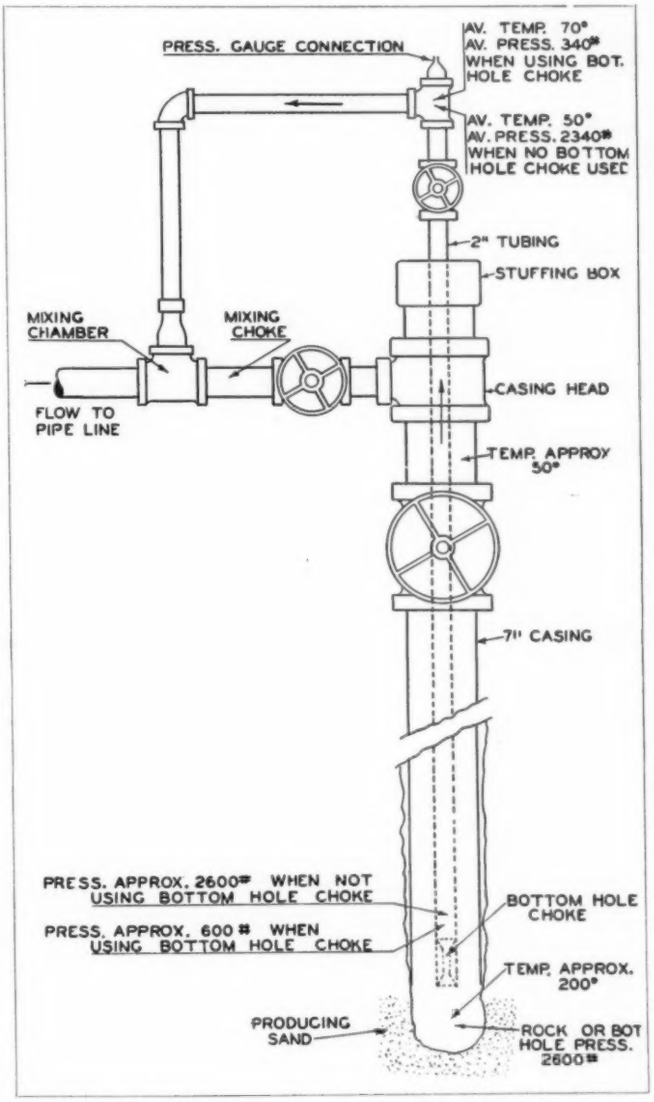
In the summer of 1931, a bottom-hole choke, good for an estimated maximum daily capacity of 1,200,000 cubic feet, was inserted in the tubing to eliminate freezing trouble. Since the choke was installed the well has been producing continuously through the tubing with an absence of freezing trouble at the well, despite the fact that the daily rates of gas withdrawal have varied all the way from 200,000 cubic feet up to 1,200,000 cubic feet, the maximum capacity of the choke. At low rates of flow some gasoline and light oil are produced with the gas, but in much smaller quantity than when the well is produced at the maximum capacity of the choke. Although no freezing trouble has been encountered at the well itself, some has occurred in the lines some distance from the well by the liquid in the gas, and, interesting to note, the freezing trouble, though not serious, seems most pronounced at low rates of flow. It would seem that the gas, on its way to the surface, undergoes a greater degree of cooling in the upper part of the tubing at low rates of flow than it does at high rates of flow. This could easily be the case if the bottom-hole temperature of the well is relatively low. This freezing in the lines, which has been greatly aggravated by excess quantities of gasoline and oil coming over with the gas, has now been overcome by the installation of a larger vertical type trap installed early in January of this year.

The owners of the well have been experimenting for months to determine within what capacity limits the choke operates most satisfactorily and find that good results are obtained at any rate of flow up to the maximum capacity of the choke. They are firmly convinced that with a bottom-hole choke more uniform operation of a gas well is obtained. By being able to produce the well through the siphon the bottom of the hole and surrounding gas sand are kept dry, thus maintaining the well in first class condition and thereby prolonging its life. Elimination of operating trouble at the well has reduced the cost of operation.

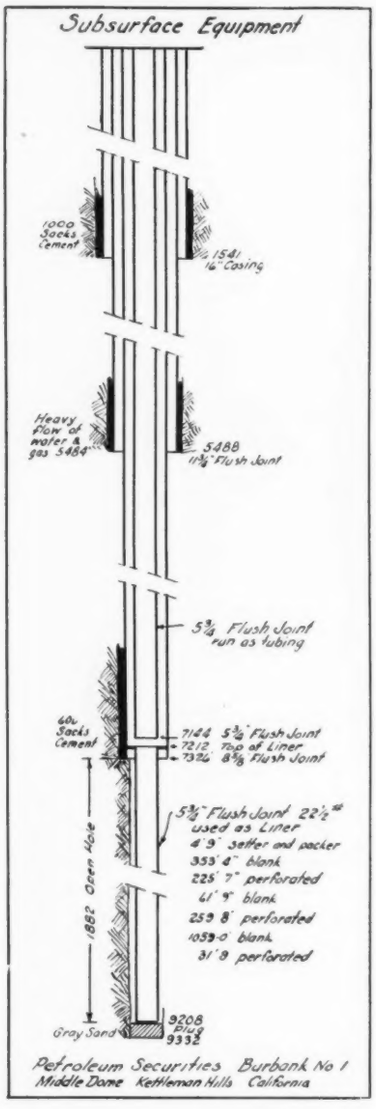
The advantages of bottom-hole choking on this well are now being felt in steady operation, effective removal of liquid from the bottom of the hole without interrupting the gas supply, and an absence of freezing at the well in the coldest weather.

Quite recently, a bottom-hole choke was installed in a gas well near Jal, New Mexico, to eliminate freezing trouble and to keep the well dry. Although no details of this installation have been received, it is reported that successful results are being obtained.

As more information on bottom-hole working pressures and temperatures becomes available, a more thorough knowledge of flow conditions in gas wells will be obtained and with it, a better realization and appreciation of the advantages of controlling the flow at the bottom of the well.



Sketch of arrangement for mixing cold high-pressure gas from the casing with warm low-pressure gas from the tubing to prevent freezing when producing a gas well through both the tubing and casing, using a bottom-hole choke. This is a feasible method of obtaining varying rates of flow from the well when the flow through bottom-hole choke is at the critical velocity. Average pressures and temperatures shown are of gas wells in Rodessa field, Louisiana, on tubing flow only.



Another Deep Record . . . and

By W. A. SAWDON

BESIDES hanging up a record as the deepest producing well in the world—to date (March 12, 1932)—the Petroleum Securities Company well started January 3, 1931, and drilled to 9,332 feet. Burbank No. 1 in the Middle Dome of the Kettleman Hills field, California, is of great importance as yielding high gravity oil on this structure. It was then plugged back to 9,208 feet where the production test was made on December 15, 1931.

Several wells have been drilled to greater depths, but none has struck oil below that from which Burbank No. 1 is producing. New lows were undoubtedly the vogue in 1931 and drilling certainly went everything one better in securing them.[1] Three wells passed the 10,000-foot depth. The first was Chanslor-Canfield-Midway Oil Company well, Hobson No. A-2, near Ventura, California, which was drilled to 10,054 feet. The deepest was Pen Mex Fuel Company's No. 35 Jardin, near Alamo, Vera Cruz, Mexico, that reached 10,585 feet. And in the Mid-Continent, the Mid-Kansas Oil and Gas Company and Ramsey Petroleum Company drilled Preston-Culp No. 6 at Cement, Oklahoma, to 10,079 feet. But none of these wells struck oil at the depths at which drilling was stopped.

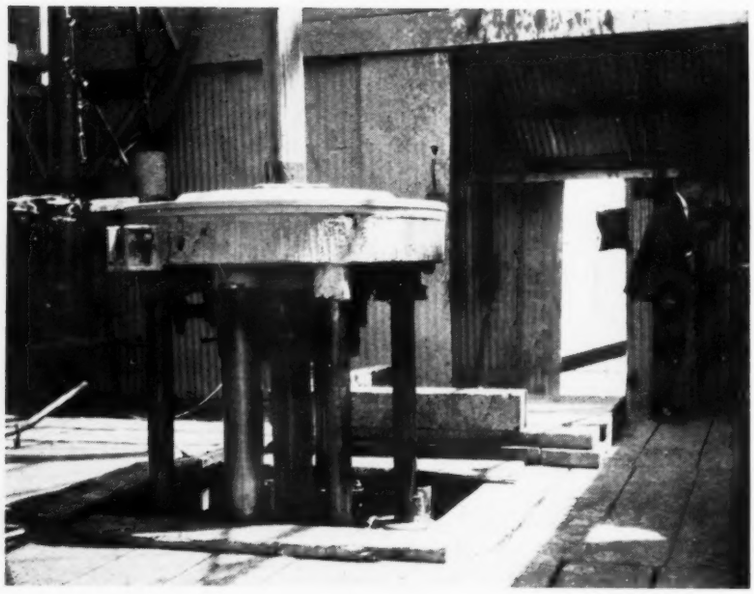
Deep producing records were, however, set up before Burbank No. 1 was completed. Associated Oil Company drilled Lloyd No. 57 in the Ventura Avenue field, California, to 8,823 feet with an initial production of 5,282 barrels of oil. Continental Oil Company's McGrath and Selover No. 24 in the Seal Beach field, California, went to 9,054 feet, but the production there secured may have come from a higher zone. With Petroleum Securities Company well Burbank No. 1 completed at 9,208 feet, however, the first assured production below nine thousand feet has been obtained and a deep producing record established.

The well was drilled completely with Hydril equipment. Electric power was used for the first seventy-three hundred feet where a change was made to steam for the final depths and the completion of the well. A great deal of coring was done throughout the entire depth and a heavy flow of water and considerable pressure had to be fought from fifty-five hundred feet down. The hydraulic equipment, however, met the conditions encountered and little difficulty was experienced in the drilling operations. Great speed was not attempted and cores were taken to obtain the most complete information possible of the subsurface conditions. From seventy-three hundred feet to the bottom, the hole was cored almost continuously.

The subsurface equipment of the well is shown diagrammatically in the accompanying illustration. A 23-inch bit was used to 1,541 feet where 16-inch, 63½-pound seamless casing was landed and cemented with 1,000 sacks. Drilling was then continued with a 14¾-inch bit to 5,484 feet where a heavy flow of water and gas was encountered. The hole was carried on to 5,488 feet and then a string of 11¾-inch, 60 pound seamless casing with Hydril flush joints was run and cemented.

Drilling from here was done with a 10⅜-inch fish-tail bit with pressure being fought continuously from this point to the final depth penetrated. At 7,326 feet a string of 8⅝-inch grade "D" Hydril flush joint casing was run and cemented with 600 sacks. The equipment was here changed over to steam with a Hydril three-cylinder steam engine replacing the electric motor for the rotary table and draw works. Steam-driven mud pumps were also installed with the electric motor-driven pumps used as stand-by units and for cementing. A Hydril sand reel was here put on for bailing tests.

Practically every foot of the 7½-inch hole carried from this point was cored. A total depth of 9,332 feet was reached with the final formation penetrated being a gray sand. The sand here seemed to be highly water-bearing so the



Elevated position of Hydril rotary table at the Petroleum Securities well.

[1] See "Deep Tests Feature Past Year's Drilling Records," by Warren Baker, The Petroleum Engineer, January, 1932.

Another Dome

Petroleum Engineer, Los Angeles

hole was plugged back to 9,208 feet for completion.

A liner consisting of 1,995 feet 10 inches of 5¾-inch, 22½-pound seamless pipe with Hydril flush joints was run to the bottom with its top located at 7,212 feet where it was hung on a liner setter. This flush joint pipe was perforated as follows:

4′-9″—Liner setter and packer.
353′-4″—Blank.
225′-7″—180-mesh perforations.
61′-9″—Blank.
259′-8″—180-mesh perforations.
1,059′-0″—Blank.
31′-9″—180-mesh perforations.

A string of 5¾-inch Hydril flush joint casing was then hung as tubing with its bottom at 7,144 feet. This arrangement is clearly shown in the drawing.

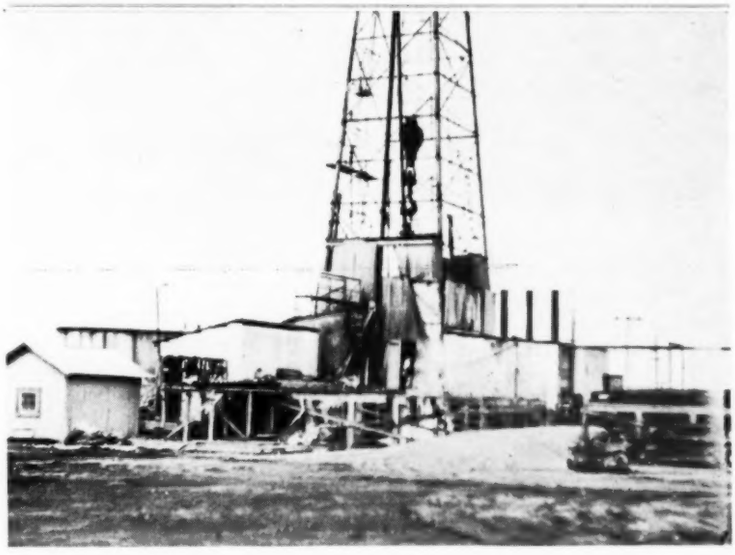
The production test was made on December 15, 1931, and showed an initial production for the well of 1,400 barrels of 50.9 A. P. I. gravity oil with 33 million cubic feet of gas. Considerable water was produced with the oil and final completion of the well will include the shutting off of this water. The oil and gas comes from the Temblor formation which is the producing zone of the North Dome.

The flow was through four 96/64-inch beans and was passed through two high-pressure and two low-pressure traps. The casing pressure was 550 pounds and the tubing pressure 360 pounds. The pressure at the high-pressure traps was 325 pounds and at the low-pressure traps was 30 pounds. The trap installation is shown in an accompanying photograph.

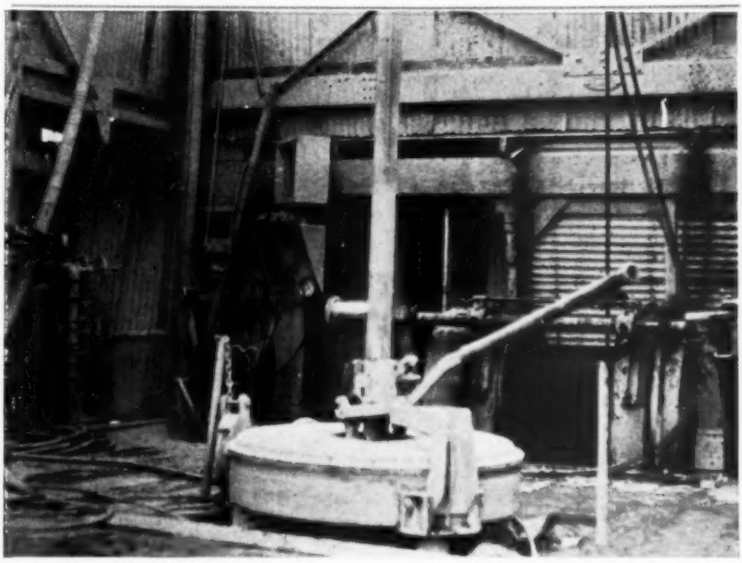
Of outstanding interest was the drilling of the entire depth of Burbank No. 1 with 5-inch, 22½-pound flush joint drill pipe. Moreover, this same string of pipe had previously been used to drill two other wells. Its total weight at the greatest depth was 203,493 pounds and it is one of the two longest strings of drill pipe of this size ever used. The other was in the North American's well N. A. Blauvet on the North Dome of Kettleman Hills which also used Hydril equipment and flush joint drill pipe.

Besides its interest as the deepest oil producing well in the world, Petroleum Securities Company well, Burbank No. 1, is important as the discovery well of a new high gravity structure in Kettleman Hills. The productive area of this structure will not be as extensive as that of the North Dome and the average well depth may be slightly greater. The Standard Oil Company holds alternate sections as it does on the North Dome and the remaining area is divided among five or six other companies. A satisfactory unit plan of operations will probably be worked out and there is little chance of competitive drilling being done. The Standard Oil Company's offset well is drilling ahead and will be the next well completed.

Two high-pressure and two low-pressure traps handling the well's production.



The well which established a new depth record for oil production.



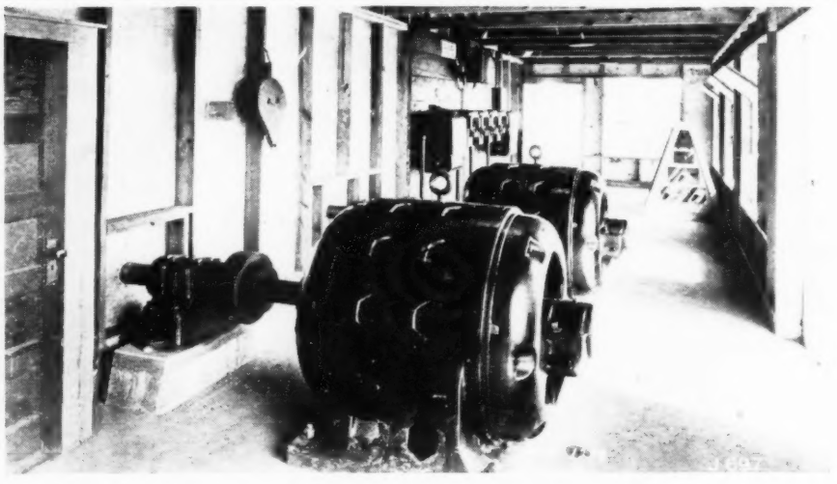
The derrick floor of Petroleum Securities well, showing automatic slip-lifter in position.

Selecting *the* Proper Motor *for the* Application

By T. D. WILLIAMSON

THE most commonplace things are usually taken for granted. For this reason they are usually not analyzed nor investigation made as to their construction.

The ordinary type of electric motor — commonly called "squirrel cage" — is so universally used that serious consideration is seldom given by the purchaser to the selection of a machine for a given application. There is seldom manifest any interest in the design or construction of the machine, these details being considered so simple that they need be given no thought.



200 horsepower, 570 revolutions per minute, 2200 volt standard squirrel cage motors operating pump in crude oil pipe line pumping station.

The object of this article is to describe in simple terms some of the principles on which the design of induction motor is based; to explain some of the terms commonly used in connection with motors; and to describe the several types of motors which are now built, with a list of applications for which each type is best suited.

The squirrel cage induction motor is the simplest electric machine now in use. The electric conductors in the rotating element consists of horizontal copper bars, fastened together at each end by means of copper rings, forming a "cage" identical with the familiar cage in which the pet squirrel was allowed to exercise, hence the name which has been applied to this type of motor. This copper winding is embedded in a laminated iron core mounted on the motor shaft which completes the rotating element or rotor.

The stationary portion consists of iron laminations, mounted in the motor frame in which are embedded the copper windings properly insulated and which are connected to the source of electric energy. There is no electrical connection between the stationary, or stator, portion of the motor, and the rotating, or rotor section. No brushes are required and the electric current is produced in the rotor windings by means of induction.

All of the electric current required to operate the motor and produce mechanical power at the motor shaft is supplied from the electric service. This current, however, is used for two purposes within the motor; a portion is required to make electric magnets of certain parts of the motor, and the balance of the current to produce mechanical energy. The ratio of the amount of electric current required to produce mechanical energy to that used in magnetizing certain portions of the motor is called the "power factor." In other words, it is a measure of the "power current" to the "magnetizing current." For a given motor the amount of current required for magnetizing purposes is constant, while the power current varies directly with the horsepower output of the motor in mechanical power. Hence, the "power factor" of a motor varies with the horsepower output, and the greater the load, the higher the ratio. Since this factor affects the efficiency of the machine, motors should be so selected that the actual load practically equals normal full load rating.

The revolutions per minute of the rotor of a motor varies inversely as the mechanical horsepower which it is delivering. When no load is connected to a motor the revolutions per minute practically equal the maximum speed at which it could operate, known as the "synchronous speed." The ratio in per cent of the difference between the actual revolutions per minute and the synchronous speed, to the synchronous speed is called the "slip." This factor varies in different designs of squirrel cage induction motors, and can be controlled to meet the characteristic desired. In some types of motors it is desirable to have the slip as low as possible, while in other cases, a large slip is required.

It is a well-known fact that more power is required to start a body in motion than to keep it moving. Since an electric motor is required both to start and continue the motion, these factors must be taken into consideration in the design of the machine. The power required to cause the rotor of a motor to rotate is called the torque—and the amount required when the mechanical load equals the horsepower rating of the motor is known as the "full load torque." The amount of power required to start a load in motion is expressed in per cent of "full load torque."

In the starting of electric motors there is a sudden rush of electric current, the magnitude and duration of which depend upon the type of starting equipment used, and also, the design characteristics of the motors. Because of the possibility of disturbing the service, power companies have set up certain rules as to the types of motors and control equipments which may be used on their power systems. The Electrical Manufacturers' Association has also compiled a

table of allowable starting currents for standard ratings of motors.

The above brief explanations of some of the more common terms used in connection with electric motors is given since these terms are used in considering the selection of the proper motor for a specific application.

The thought and care represented by the modern squirrel cage induction motor cannot be fully appreciated by the purchaser. The machine appears to be so simple that it is difficult to realize that an engineer used many pages of figures in calculating the various factors entering into the design and construction of the motor. The ultimate results for which this engineer was striving, in order to produce as nearly a perfect machine as possible, may be summarized as:

(1) Cool operation.
(2) Low upkeep costs.
(3) Best possible bearings.
(4) Sealed bearing housings.
(5) Minimum vibration and noise.
(6) Neat and attractive appearance which will match the finest surroundings.
(7) Simplicity of construction resulting in ease of repairs.
(8) Years of reliable service.

Until but a few years ago electrical manufacturers attempted to produce but one type of squirrel cage induction motors for all classes of application. The only exception to this was in case of such abnormal operating conditions that a special design was required. However, with the modern trend of engineering practice toward greater efficiency, it has been found that one type of squirrel cage induction motor will not fulfill the requirements of a number of different operating conditions, hence seven standard and distinct types of these motors have been designed and developed to meet as many specific and "standard" types of applications.

Type No. 1—Standard Squirrel Cage Motors—General Purpose

This type covers the original squirrel cage motor which was designed to take care of all applications. The electrical characteristics of this design qualifies it for an almost unlimited variety of applications, such as group or individual drives, in machine shops, on machine tools, fans, blowers and centrifugal pumps—or any application where normal starting torque motors are recommended.

With full rated voltage applied to the motor terminals, the eighteen hundred revolution motor will develop a minimum starting torque of 150 per cent of full load torque. At no load, the speed is practically equal to the synchronous speed, and as load is applied the speed falls off uniformly up to full load, where it is approximately 95 per cent of synchronous speed. Since these motors operate at nearly constant speed from no load to full load, they are often referred to as "constant speed motors."

Many power companies have established limitations on the amount of current motors may draw at starting. The purpose is to reduce power fluctuations and prevent flickering of lights. These limitations usually provide that motors over seven and one-half horsepower in size must use reduced voltage starting equipment.

In localities where starting currents are limited, the application of this type of motors is limited to machines which do not require a heavy starting torque, such as fans, blowers, centrifugal pumps, and machine tools. If the starting torque is below that required, type No. 2 motors should be used.

Type No. 2—Normal Torque Low Starting Current—"Across the Line" Motors

This type of motors develops starting torques approximately the same as type No. 1, and they can be started directly across the line without exceeding the power company's starting-current requirements. No current-reducing starting devices are required, a simple hand-operated starting switch, or an across-the-line type magnetic motor switch, operated by a push button or other device, is all the starting equipment needed.

These motors are intended for installation when starting current limitations require the use of compensators (current-reducing starters) with type No. 1 motors, and where

The Following Table Summariazes These Seven Types of Motors:

Type	Standard Ratings	Type of Starter Ordinarily Used	Applications
No. 1	1/10 to 500 HP. 3 or 2 phase 110 to 2200 volts	Across the line up to 7½ HP. Reduced voltage above 7½ HP.	Groups or individual drives, in machine shops, on machine tools, fans, blowers, compressors, centrifugal pumps, or any application where normal starting torque motors are satisfactory.
No. 2	7½ to 30 HP. 3 or 2 phase 110 to 2200 volts	Across the line starter for all ratings	Same as type No. 1, standard squirrel cage motors.
No. 3	40 to 100 HP. 3 or 2 phase 220 to 2200 volts	Across the line starter for all ratings	Centrifugal pumps, agitators, fans and blowers, generator sets, and other applications requiring low starting torque
No. 4	3 to 30 HP. 3 or 2 phase 110 to 2200 volts	Across the line starter for all ratings	Crushers, plunger pumps, belt conveyors, starting under load, large air compressors, large refrigeration machinery, mixers and other applications requiring high starting torque
No. 5	40 to 100 HP. 3 or 2 phase 220 to 2200 volts	Reduced voltage starting equipment where required by power company, otherwise across the line type will be satisfactory	To be used where the starting torque of type No. 1 motor is too low, since this type motor has high starting torque characteristics.
No. 6	1 to 150 HP. 3 or 2 phase 110 to 2200 volts	Across the line starter for all ratings	Punch presses, shears, metal drawing operations, balers and other machinery equipped with flywheels or having flywheel effect
No. 7	1 to 30 HP. 3 or 2 phase 110 to 550 volts	Across the line starter. Very low starting current	Elevators, cranes, hoists and dumb-waiters.

the reduction of voltage at starting lowers the torque of type No. 1 motors below that required.

Type No. 3—Low Torque Across the Line Motor—40 Horsepower and Larger

These large motors can be started directly across the line without exceeding the starting-current limitations established by the power companies. No current-reducing starting devices are required; a simple hand-operated starting switch, or in case of remote control, an across-the-line type magnetic motor switch, operated by push button or other device is all the starting equipment needed.

The starting torque of type No. 3 motors is, however, somewhat lower than that of type No. 1 motors of the same ratings, operated without compensations. For across-the-line (type No. 2) motors of 30 horsepower and below, the starting-current allowed is high enough to permit normal starting torques. However, above 30 horsepower the starting-current allowed is so low that normal starting torque cannot be developed. These motors, which are designed to operate within the prescribed starting-current limits, will develop a starting torque of about 80 per cent to 100 per cent of full load torque, and are, therefore, known as "low torque" motors.

These low torque, type No. 3 motors are suitable for such applications as centrifugal pumps, agitators, fans, blowers and other machinery requiring very low starting torque.

Type No. 4—High Torque, Low Starting-Current (Across-the-Line) Motors—30 Horsepower and Smaller Double Squirrel Cage Rotor

Type No. 4 double squirrel cage rotors develop a starting torque of from 200 per cent to 250 per cent of full load torque, a starting torque one-third to two-thirds higher than the type No. 1 motors. Although having this high starting torque, the starting-current is within the prescribed limits and the motors can be started directly across the line, without the use of current-limiting starting devices.

The desired combination of high starting torque with low starting-current is effected through the unique construction of the rotor. The double squirrel cage motor has what its name denotes: two separate squirrel cages, one of smaller dimensions inside the other and both embedded in the same laminated iron rotor core. The outer squirrel cage is so designed as to effect high resistance and low reactance, and the design of the inner squirrel cage is such as to produce the effect of low resistance and high reactance. At start, the rotor currents have line frequency and the larger part of the rotor currents follow the low reactance path of the outer winding, while the inner winding is less active because of its high reactance which opposes the flow of current as long as the frequency of the rotor currents are near that of the power service. As the rotor comes up to speed, and the frequency of the rotor currents decreases, the reactive effect of the inner winding decreases, allowing the inner winding to carry the large part of the rotor currents and thereby to carry a large part of the load. Thus the outer squirrel cage effects high starting and accelerating torque with very little line disturbance, while the inner winding assures ample running torque and good efficiency.

Type No. 5—High Torque Low Starting-Current Motors—40 Horsepower and Larger—Double Squirrel Cage

These motors are the same as type No. 4 electrically and mechanically. They should, however, be treated as a separate group, as their starting-current exceeds the prescribed limits, and for this reason they involve the use of current-reducing starting devices wherever starting currents are regulated.

With rated voltages applied, type No. 5 motors develop the same high torques as type No. 4 motors, described in the previous section. When started under reduced voltage to meet the power company regulations, their starting torques vary as the square of the voltage applied to the motor terminals. At 80 per cent rated voltage the starting torque of an 1800-revolution type No. 5 motor is reduced to approximately 160 per cent of full load torque, which is considerably higher than that of a type No. 1 motor started at the same reduced voltage.

Type No. 6—High Torque Punch-Press Motors—Flywheel Applications—High Slip

Type No. 6 motors are intended for driving punch presses, shears and other heavy inertia machinery operating under heavy fluctuating load conditions, machines which either are provided with flywheels or have flywheel effect.

The function of the flywheel is to store energy as the machine idles, and to deliver the stored energy during the punching, shearing or other operation. In order to do this, the flywheel must be allowed to slow down during each operation, and must be quickly accelerated to full speed immediately after to prepare it for the next operation. The proper motor for such a service is one which has (1) high slip to allow the flywheel to release its stored energy, (2) high starting torque to overcome inertia of the heavy flywheel, (3) quick acceleration to bring the flywheel up to full speed at the start and after each operation.

Type Nos. 1 to 5, inclusive, are low slip, constant speed motors, inherently unable to slow down to let the flywheel do the work; they would attempt to keep the flywheel revolving at a constant speed, and would consequently create considerable line disturbance by drawing excessive current each time the machine is doing work. They also have considerably lower starting torque than type No. 6 punch-press motors, for which reason machines would have to be heavily overmotored to start the heavy flywheel.

Type No. 7—High Torque Elevator Motors

Type No. 7 elevator motors are intended for elevator service, or such similar applications as cranes and small hoists, requiring: (1) very high starting torque, (2) frequent stopping, starting and reversing, (3) low starting current; and do not require: (1) constant speed, (2) adjustable varying speed, (3) long periods of operation.

Economies which are effected by the selection of the proper motor for the application may be summarized as follows: (1) reduced initial cost of the motors, since overmotorizing would not be required to start a heavy load; (2) lower power cost, due to higher efficiency and higher power factor. Also the power demand charge is less since smaller motors may be used for a certain load; (3) longer life and reduced maintenance costs, since undue strains and overloads would be eliminated; (4) simplified and cheaper motor starting equipments, when across-the-line type motors may be selected. In addition to the seven types of electric motors, which have been described, the following mechanical variations are available to meet certain specific needs:

Totally Enclosed, Weatherproof Motors

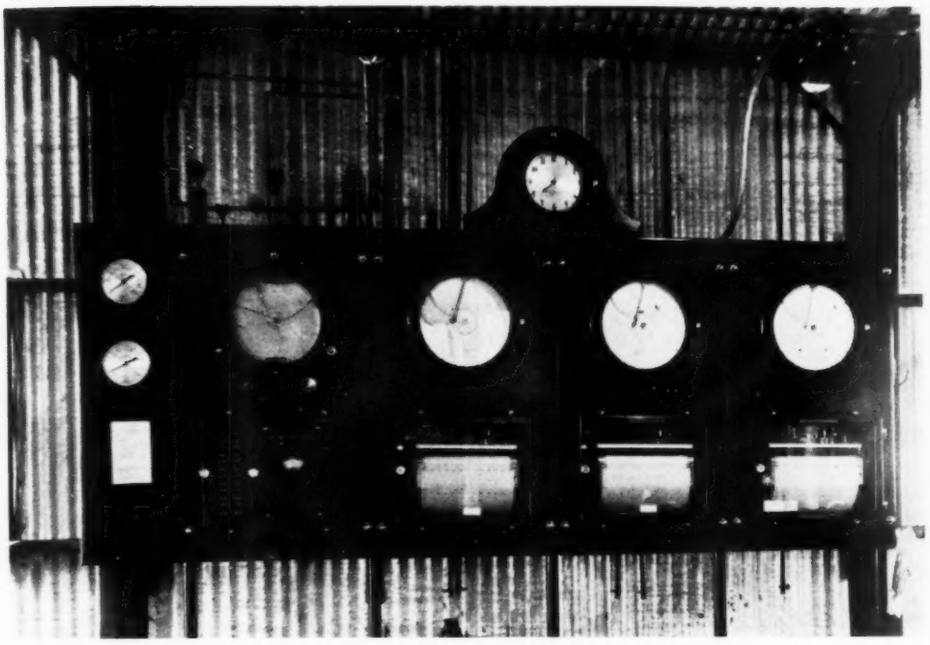
These motors are intended for use in locations where considerable dust or dirt is present, and out of doors where no shelter is provided. A large number of these motors have been installed out of doors, and are used to drive centrifugal pumps.

"Explosion Proof" Motors

The National Board of Fire Underwriters has passed a ruling that motors which are installed in rooms containing explosive gases or vapors must meet its specifications, and be subject to its inspection. These motors have been designated as "explosion proof" motors, and they are extensively used in the oil industry.

High Temperature Control in Refineries

F. M. POOLE and G. S. YOUNKIN*



Modern Control Instrument on distillation unit. Petroleum Refractionating Co., Longview, Texas.

HIGH temperature control in a refinery is accepted to mean the adjustment of fuel supply to a tube still to maintain a desired hot oil outlet temperature. This is true regardless of whether the adjustment is manual or automatic.

Further, it should be readily recognized that the best type of temperature control is that which an intelligent and experienced operator can give—provided he is alert and doing justice to his ability. The operator has the capacity to recognize that there is a difference in the rate of temperature change and makes his adjustments accordingly. If it were possible to have intelligent and experienced operators capable of utilizing their intelligence and experience sixty minutes of every hour, there would be little need for an automatic control. Unfortunately, such operators are not always available. What is more unfortunate, even the best of operators cannot carry on continuously at their best efficiency—they become tired. Too often the tired moments equal or exceed the operator's alert moments.

With this background there has been developed automatic temperature control for tube still operation. From the beginning the manufacturer has attempted to simulate in his control apparatus the action of an efficient operator. The manufacturer isolated the operator's basic operation, namely, when the oil temperature was low, he increased the fuel supply and vice-versa when the oil temperature was high.

The first type of control was a simple reproduction of this basic operation. A pyrometer indicated or recorded the temperature of the oil. When the temperature fell below the desired point, an impulse was transmitted to a motor operated valve mechanism, causing the valve to open a predetermined amount usually slightly more than that required to hold the temperature at the desired point. When the temperature rose above the control point, the reverse was true. The result was a "saw-tooth" appearing record inasmuch as the fuel supply was continuously being increased and decreased to corral the temperature as nearly as possible to the desired control point. The limitation of this type of control was that the valve mechanism could assume only two positions, one slightly more, and the other slightly less than the actual amount required—a condition necessary because of the lag between a given fuel supply change and the result as shown on the instrument. Whenever the oil, amount of through-put, or other operating condition changed, it was necessary for the operator to increase or decrease the minimum fuel supply; in other words, open or close the by-pass. It was evident that such a type of automatic control did not eliminate the human factor, the justification for the development of high temperature control.

An improvement in the apparatus was a so-called three-position motor valve mechanism. In such a motor valve mechanism there were three positions—a normal, a slightly high, and one slightly less than the desired or normal fuel supply. The advantage of this mechanism was that it minimized the temperature surges in the unit; the "saw-tooth" appearing record was smoothed out. It had the same limitations—but to a lesser degree—as had the two-position mechanism described above.

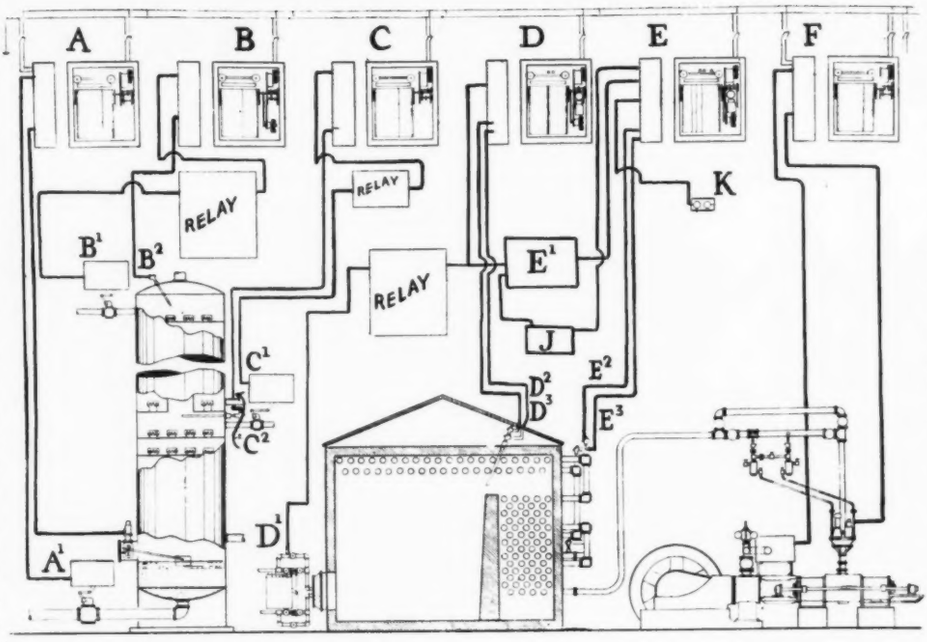
Further Elimination of Human Factor

The manufacturer visualized that the operator's sequence of action, carried to the extreme, in the temperature control of his still would be:

(a) He would stand with his hand upon the fuel adjusting valve and with his eye on the indicating pyrometer. He

* Brown Instrument Co.

would juggle the fuel control valve back and forth from a position slightly more open to a position slightly more closed. Such action would break any temperature momentum either up or down; in other words, he would attempt to corral the temperature as closely as possible to the desired control point in much the same manner as the two-position mechanism described here.



Typical tube still installation.

(b) He would note at times that it was necessary for him to hold the valve, say in the open position, a slightly longer time than in the closed position, or vice-versa. In other words, he would recognize this as meaning that there should be an increase or decrease in the minimum fuel supply; this he would do by opening or closing the by-pass valve.

The manufacturer realized that he must duplicate mechanically the action of this operator when carried to the extreme. Such sequence of action could not be performed with a single motor mechanism inasmuch as the difference in unit adjustment was too great. The operation could only be simulated by means of a valve mechanism incorporating two motors. There was evolved what one manufacturer characterizes as his counter-acting control valve mechanism.

This counter-acting mechanism is made up of two motors. The action of one of these motors follows very closely the action of the two-position motor valve mechanism described above. The second motor gives very minute unit adjustments, the valve of which increases as the temperature deviates from the desired control point. The combination of the action of these two motors practically duplicates the sequence of action of the operator as outlined above. A patented refinement appears only in this counter-acting two-motor mechanism. When the temperature has deviated, say above the control point, and reversing its trend, again approaches the control point, the two-position or so-called "hammer-blow" motor takes the opposite position as though the temperature had dropped below the control point. In other words, it is recognized that the temperature would probably coast beyond—by taking the closed position, this tendency to coast by the control point is reduced and in some cases eliminated. The sequence of action of this counter-acting two-motor valve mechanism is illustrated diagramatically in the sketch below.

Figure No. 1 shows the valve mechanism assembly connected to a valve. The initial motor and the secondary (or floating) motor are connected to the valve lever. The initial motor, as mentioned above, can assume only two positions. The secondary motor moves very slowly but can take any number of positions. Figure No. 2 illustrates the instrument pointer with respect to the contact table steps and depressor bar. The solid lines in Figure No. 3 represent the permanent position of the control valve; the dotted lines represent the temporary positions assumed by the control valve moving from the original permanent setting to the new permanent setting.

Assume that the control point as indicated by the arrowhead on the depressor bar is 1500 degrees and that the pointer is directly under this control point on the neutral step; the valve position happens to be exactly half-way between open and close position of the valve. Assume for various reasons that the temperature starts to increase and moves from 1500 degrees to 1505 degrees. This causes the first high step on the table to be selected. Two actions follow:

(a) The initial motor moves a material amount toward the closed position to give a hammer-blow correction to

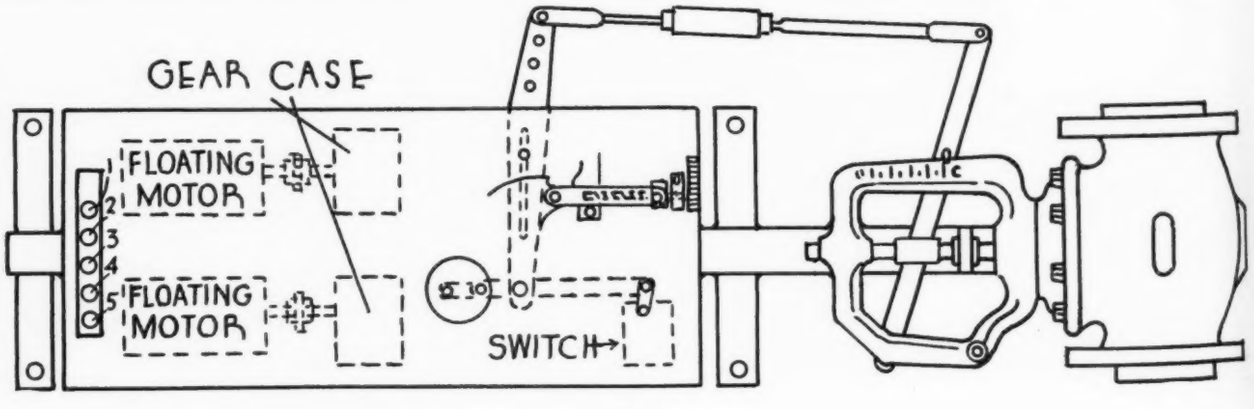


Fig. 1

On this INTERNATIONAL HOOK-UP

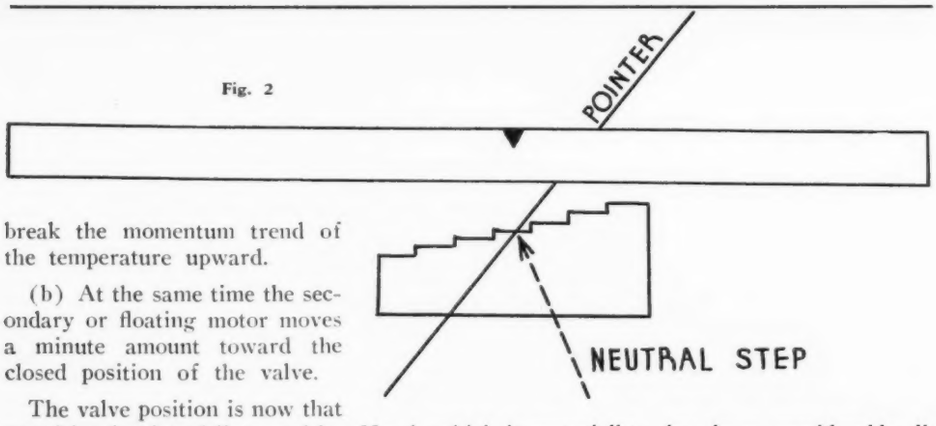
UNSEEN, perhaps, but necessary, is the Dresser-Coupled gas line underneath the Peace Bridge that connects Buffalo (N. Y.) with Fort Erie (Ont.). Continuous pounding of traffic subjects this line to countless shocks and vibrations, and that is why Dressers are there. No other joint would insure such flexibility, tightness, permanence.

S. R. DRESSER MFG. COMPANY
Bradford, Pa.

Canada — Dresser Mfg. Company, Ltd.
32 Front Street, W., Toronto, Ontario

DRESSER COUPLINGS *DOMINATE!*

Fig. 2



break the momentum trend of the temperature upward.

(b) At the same time the secondary or floating motor moves a minute amount toward the closed position of the valve.

The valve position is now that noted by the dotted line, position No. 1, which is materially nearer to the closed position than its former position. A slight interval of time elapses without action in order that the instrument may ascertain what is the response of the temperature to these corrections. If the temperature remains high or attempts to go higher, minute adjustments—increasing in value as the deviation becomes greater—are made by the secondary motor, such as illustrated by the dotted positions 2 and 3.

The valve continues to move toward the closed position in increasing increments until the temperature momentum upward has been fully broken and the trend reversed. After the trend has reversed and the temperature approaches the desired control point, 1500 degrees, the initial motor only functions to give a hammer-blow in the reverse direction—this is the patented feature mentioned above. This reversing of the hammer-blow as the temperature approaches the control point nullifies the tendency of the temperature to coast beyond the control point. The net result as far as the valve position is noted by the solid line labeled "new permanent setting" in the diagram.

As pointed out above, the combination action of these two motors, particularly with the patented "backing off" feature, simulates the action of a good fireman. All good firemen will over-correct and then back off on their adjustment whenever they see the temperature start to build up a momentum upward or downward.

This improved type of counter-acting control has been in operation for some five or six years and in many refineries throughout the country, notably, Continental Oil Company, Barnsdall Refining Company, Standard Oil Company, Skelly Oil Company, White Eagle Oil Corporation, and many others.

By means of this two-motor valve mechanism, the necessity for the operator changing his by-pass is eliminated as the by-pass is kept closed. In other words, a step forward is made in eliminating the human equation.

Robot Operator Evolved

At least one manufacturer recognized that if high temperature tube still control were going to be entirely satisfactory, it was not enough to duplicate one or two isolated operations on the part of the operator. While it is true the operator's primary concern is to maintain a constant hot oil outlet temperature, he has other responsibilities. For example, the operator might want to bring back the oil temperature which has deviated at a slower rate as a protection to his masonry or from the hazard of hot spots. An operator, noting his furnace temperature was droping off or increasing, would realize that sooner or later such increase or decrease in furnace temperature—with the same through-put—would effect his oil temperature; but he might correct the fuel supply before the oil temperature had actually been effected.

Because of these facts, there has been considerable discussion as to what is the logical way to control a tube still. Should the fuel supply to a tube still be controlled directly from the oil temperature or should it be controlled from the furnace temperature? Unquestionably there were advantages to both schemes; unfortunately either one is a compromise. In no sense will it duplicate the action of the operator under all conditions.

Variation in the B. T. U. value of the fuel, a change in wind conditions, or change in draft condition will effect the furnace combustion temperature before the oil temperature. Therefore an automatic tube still control of fuel supply should be energized from changes in furnace temperature inasmuch as the effect of the above-mentioned variables would be minimized or eliminated before they could effect the oil temperature. While this was quite true, it is also true that a given oil temperature, which is what is desired, does not correspond for any particular length of time to the same furnace combustion chamber temperature. The reasons for such a varied relationship are:

(a) The quality of the oil itself might change.

(b) There might be an increased or decreased soot deposit on the tubes which would affect the rate of heat transfer.

(c) The rate of flow might change.

These are the facts brought out by the exponents of the control of tube still fuel supply direct from oil temperature. They point out that since it is a constant oil temperature that is desired, the control of tube still fuel supply must be energized from oil temperature. They further point out that while the operator may note changes in furnace combustion chamber temperature and adjust his fuel supply accordingly, it is the final oil temperature that is his master guide in the operation of the unit.

As a means of recognizing the merits of both of these schemes and at the same time duplicate what an operator would do under all conditions, one manufacturer has

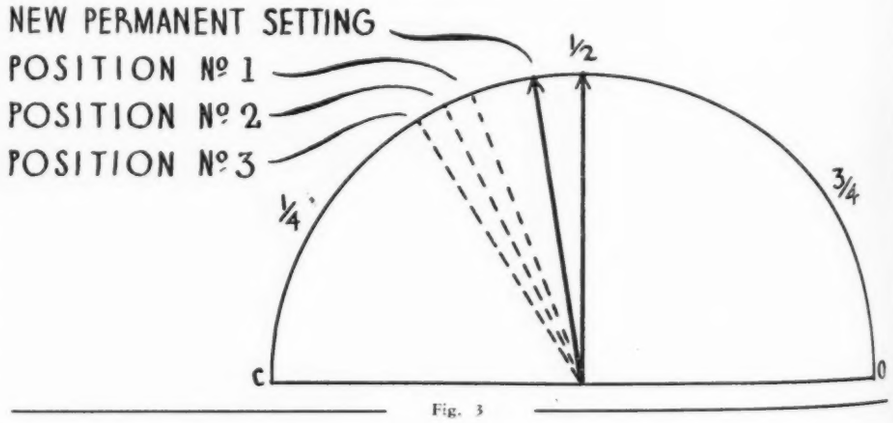
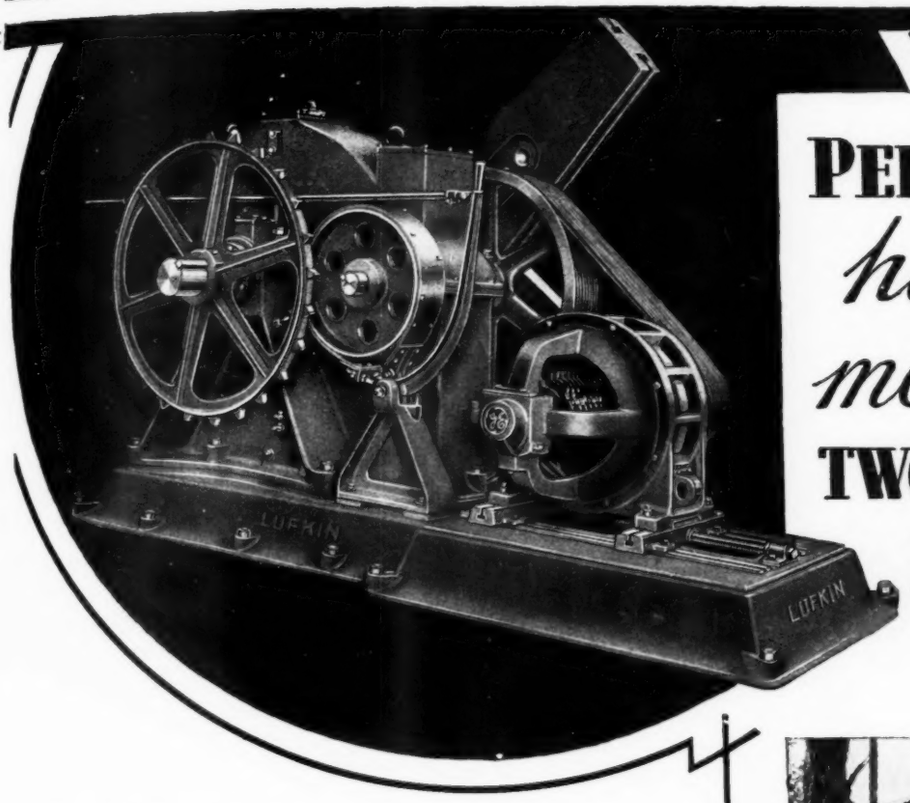


Fig. 3

PERFORMANCE

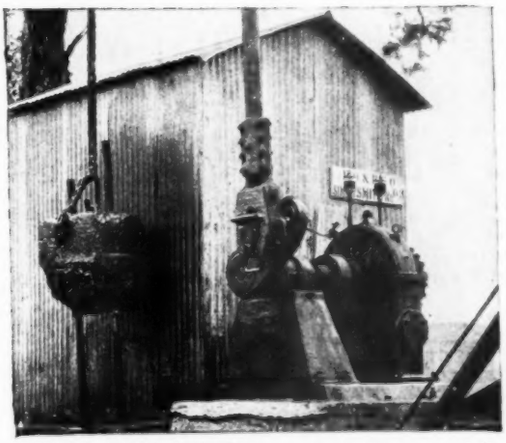


PERFORMANCE *has sold more than* TWO THOUSAND LUFKIN UNITS

EFFICIENT PERFORMANCE in the field under all sorts of operating conditions—with a minimum of operating and maintenance expense—(SO VITALLY IMPORTANT TODAY)—is almost wholly responsible for the phenomenal success of Lufkin Units. So adequately have Lufkin Units passed the rigid requirements of the well-organized Engineering Departments of Major Operators that order after order has reached us as a result entirely of this department's findings and recommendations.

Ease of adaptability to any type prime mover—entire elimination of fire hazard and large expensive belt and band wheel houses and the attendant upkeep of such—lowered production costs and increased operating efficiency—ease of transfer from lease to lease (with loss of only the foundation)—these and countless superior characteristics make LUFKIN UNITS the ultimate in Modern Production Equipment.

Without obligation, Lufkin Representatives will gladly submit complete details and specifications of the equipment best suited for your lease—ALSO—a completely illustrated catalogue containing blue print setting plans and "hook-ups" of all types of applications will be gladly mailed upon request.



LUFKIN'S FIRST UNIT—This unit, now operating on a Gulf Coast lease after pumping three wells dry, while crude in design compared to the present day Lufkin Unit, is still performing in an efficient manner. Several hundred units have been sold to this operator as a result of the performance of this unit.

LUFKIN
PRODUCTION EQUIPMENT

»»»» Manufactured at Lufkin, Texas, by ««««

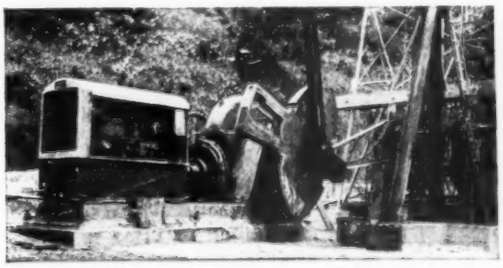
LUFKIN FOUNDRY AND MACHINE CO.

»»»»»» Branch Offices and Warehouses ««««««

HOUSTON, TULSA, LOS ANGELES, NEW YORK, ODESSA, SEMINOLE, ELDORADO

EAST TEXAS HEADQUARTERS: Henderson, Texas, on Crim Crest Hill, P. O. Box 516—Phone 142.

CALIFORNIA DISTRICT: 5959 S. Alameda Blvd. E. P. Trout, District Manager.



Dependable performance is the thing required by the foreign buyer—that is why LUFKIN UNITS are favored in foreign fields. Above is an installation in the Francito field, Puerto, Mexico. Several hundred Lufkin Units are operating in South American and other foreign fields.

brought out a mechanical robot operator. This robot is known as a Furnace-Hot Oil Interlock Tube Still Control.

The sequence of operation of this Furnace-Hot Oil Interlock Tube Still Control is as follows:

1. By means of a single hammer-blow movement in the initial motor—to break the momentum trend—accompanied by numerous minute and proportional adjustments of the second motor in the same two-motor valve mechanism to change the minimum supply, the fuel supply to the tube still is varied to derive the average temperature over the bridge wall desired at that particular moment to give the required oil temperature.

(It is recognized that a mechanical robot cannot note leaky oil lines or other fire hazards which a human fireman might observe. It is not desired to eliminate the human operator altogether but only to duplicate his best efforts all the time. Therefore the responsibility of balancing the several burners to give an equal load distribution on both ends of the furnace is left to him. A record of each end of the furnace is produced on the control instrument chart—which also records the average and controls from it. These records, one at each end of the furnace, act as a check as to whether the fireman has maintained the proper distribution and in doing so afforded protection against fire hazards. Should he fail to maintain a proper balance, the heat in-put into the still is not affected inasmuch as the control operates from the average of the furnace combustion chamber condition. It merely means that one end of the furnace is overloaded with respect to the other.)

2. The oil instrument recognizes that the furnace temperature necessary to give a predetermined oil temperature will vary from minute to minute. Therefore the oil instrument raises or lowers the furnace control point setting by the necessary amount and at a rate to hold the oil temperature at a value selected by the operator.

In changing the furnace fuel valve position or the furnace control point setting, the amount of the change and the rate at which the change is made result not only from the actual temperature deviation, but also the rate at which the temperature has deviated—the furnace temperature in one case, the oil temperature in the second case. In other words, the adjustments are made from the trend of the variable as well as the actual deviation itself. The interlock tube still control varies the fuel supply exactly as an operator would do it when he is fully alert and capable of utilizing his maximum mental capacity. This mechanical scheme has the advantage that the sequence of operation is continued hour after hour without loss of efficiency.

The particular manufacturer who has developed this patented mechanical robot known as the Furnace-Hot Oil Interlock Tube Still Control believes that he has reduced materially, if not eliminated, the human factor without increasing the hazard of excessive furnace or oil temperatures. He points out that the operation is reduced to a simple, almost routine, job.

(a) The stillman sets the oil instrument to the oil temperature at which he desires to operate the still. By this same operation, he automatically establishes a danger point for the oil temperature, usually 15 degrees to 25 degrees above his normal operating oil temperature. (Should for some unforeseen reason the oil temperature reach this danger point, the oil instrument would function to cut out temporarily the furnace control and to energize the two-motor fuel valve mechanism directly, reducing the fuel supply sufficiently until the oil temperature drops below the predetermined danger point. At such a time the oil instrument would relinquish control over the two-motor fuel valve mechanism and the furnace control would again function as before; the operation would then continue as described above.)

(b) The operator does not pay any particular attention to the furnace control instrument except in the beginning to establish a maximum furnace temperature to be permitted. This maximum is usually the maximum temperature which the furnace masonry and tubes can withstand. Should the oil instrument attempt to raise the furnace control point setting above this predetermined maximum in order to maintain the predetermined oil temperature, this safety furnace maximum setting would operate to maintain the furnace temperature at this predetermined maximum but no higher, regardless of the fact that the oil temperature might remain low.

(c) If the operator desires to raise or lower the oil temperature, he merely raises or lowers the oil instrument control point setting. Impulses are then sent from the oil instrument to the furnace control instrument by an amount and at a rate proportional to the amount which the operator has raised or lowered the oil control point. By making such changes from the trend, over-shooting is practically eliminated. If the resulting oil temperature is satisfactory, the control reaches an equilibrium. If the resulting oil temperature is not satisfactory, further adjustments are carried on in the same manner. In other words, the furnace temperature is held constant at the last control point selected as long as the oil temperature is satisfactory.

The advantage of using such a patented mechanical robot, reproducing the action of the operator under all conditions over the temperature control which duplicates one or two isolated operations of the operator under certain conditions, is outstanding. You approach the condition of utilizing continuously your best and most intelligent operator at his maximum efficiency all of the time. This is money in the profit column.

It is needless to say that this Furnace-Hot Oil Interlock has made a distinct impression on a number of refineries. Installations as illustrated in the diagram below are now in operation at Skelly Oil Company. Installations are going in at a number of outstanding refineries, such as The Standard Oil Company and Kanotex Refining Company.

Referring to the sketch showing the "Typical Tube Still Installation":—

A—Illustrates an electric liquid level control for tower bottoms.

B-C—Tower temperature controls using the counteracting type control described above.

D—Furnace recording and controlling instrument connected to two thermocouples D^2 and D^3 located at each end of bridge wall.

E—Hot oil recording and controlling instrument connected to E^2 and E^3, also to hot oil outlet.

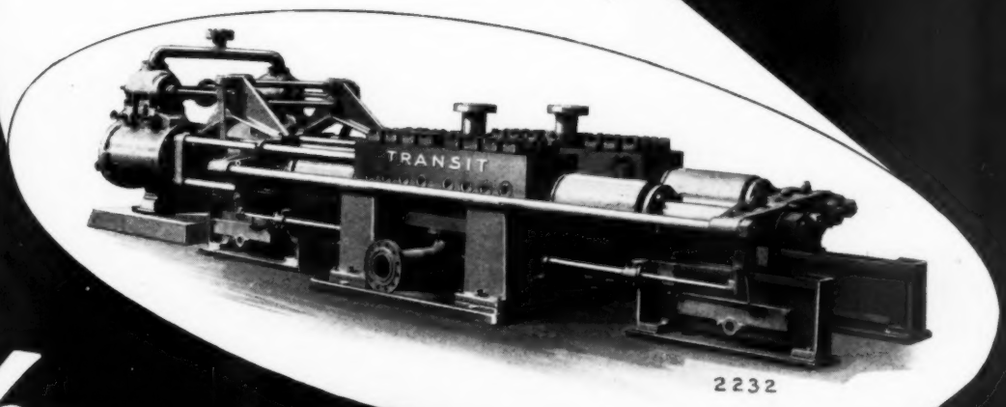
D and E are interlocked through relay panel E^1.

F—Illustrates an electric strip chart flow control—controlling a crank and fly wheel pump through corrections made to a fly ball governor. The fly ball governor is automatically set for the required number of pump strokes to produce a given rate of flow.

K—Shows two bull's eye lights. One of the lights indicates when the furnace temperature approaches the predetermined danger point. The other lights when the hot oil approaches the predetermined maximum.

TRANSIT hot oil PUMPS

are in the spotlight



-the refiners' favorite

REFINERY PUMPS
FOR HOT OIL
and many other refinery service

TRANSIT (CURTIS)
ROTARY PUMPS

PIPE LINE PUMPS

BEAUMONT, TEXAS
E. L. Wilson Hardware Company

SALT LAKE CITY, UTAH
F. C. Richmond Machinery Co.

NATIONAL TRANSIT
PUMP & MACHINE CO.
OIL CITY, PA.

NEW YORK PHILADELPHIA CLEVELAND PITTSBURGH LOS ANGELES HOUSTON TULSA NEW ORLEANS

PHOENIX, ARIZ.
Pratt-Gilbert Co.

LOS ANGELES
Republic Supply Company of California

ST. LOUIS, MO.
Reeves & Skinner Machinery Co.

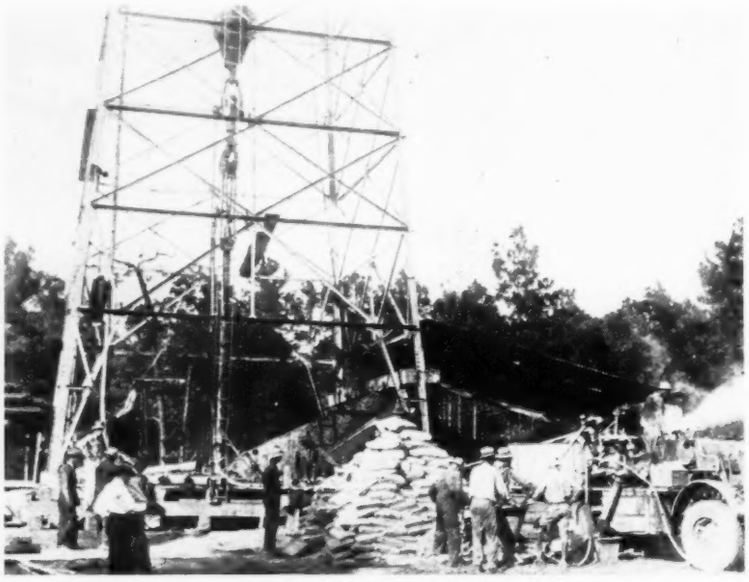
FIELD PUMPS
TOOLS
for Pipe Line Construction

GAS ENGINES
GAS ENGINE GAS COMPRESSORS

Multiple Stage Cementing Process Used in East Texas

MULTIPLE stage cementing is the latest development in oil-well cementing practice. Two wells have recently been cemented in East Texas by this method and much interest has been aroused among operators in that field. The process shows great possibilities in deep well cementing also, as it overcomes difficulties commonly encountered in cementing long strings of casing.

Originally conceived by Earle P. Halliburton, of the Halliburton Oil Well Cementing Company, to simplify the cementing of long strings of casing with large quantities of cement, the new process makes it possible, by means of one or more special casing devices, to pump cement behind a string of casing at two or more places, either simultaneously, consecutively, or at brief intervals. It eliminates the necessity for pumping all the cement down the entire length of casing, around the shoe, then all the way up ouside the casing. It eliminates the extremely high pressures necessary to place large quantities of cement behind long strings of casing. As it shortens the time necessary to cement a long string of casing with a large quantity of cement, two other important advantages are obtained; first, all the cement can be pumped into place before it begins to set; second, the cement, excepting the portion that passes around the shoe, is not exposed to the high bottom-hole temperature, an advantage of great consequence in deep wells.



Although multiple stage cementing was developed primarily to facilitate the cementing of deep wells, the process was adapted to East Texas wells for other reasons. In certain parts of the East Texas field, municipal authorities require that an extra string of casing be landed and cemented at a depth just below the artesian water sand which lies at about 1,000 feet, in order to protect the water from contamination. This means that if it is desired to complete a well with a seven-inch production string, an operator must set 15½-inch surface pipe, then land and cement about 1,100 feet of 10-inch casing to protect the artesian water sand. By using the multiple stage cementing process the Halliburton Oil Well Cementing Company was able to land and cement the seven-inch casing above the oil sand and at the same time cement off below the artesian water sand behind the seven-inch casing.

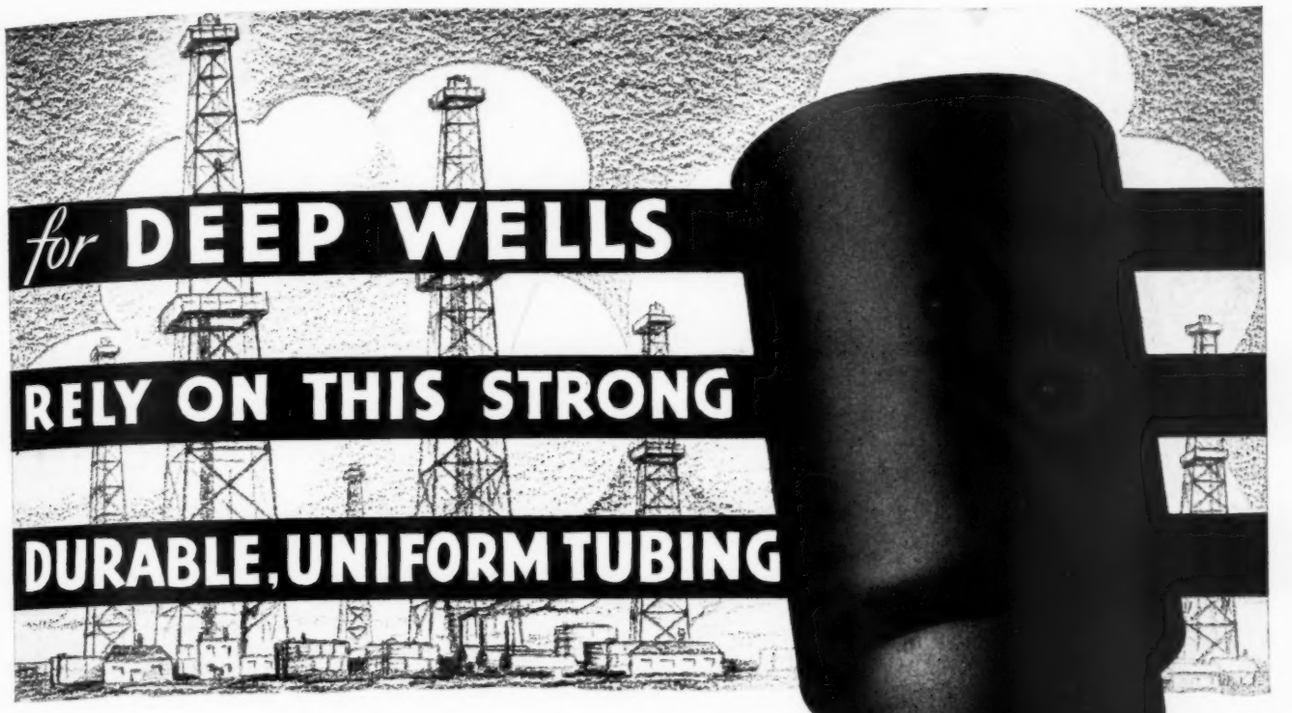
For shutting off the artesian water sand using only one string of casing, the new process of cementing was authorized for trial use by Mayor B. F. Phillips, Mr. Pundt, and Mr. J. W. Clark, city officials of Gladewater, on the Humble Oil and Refining Company's well, Della Johnson A No. 1, in the Gladewater townsite. The cementing job was successfully carried out on February 15, 1932.

It is believed that the approval of multiple stage cementing for general use in the East Texas field will enable state and municipal authorities more easily to enforce their protection program on water, and with less hardship on the operator, as it will mean an estimated saving of more than $1,000 on each well. As adapted to conditions in the East Texas field, the multiple stage cementing consists of dividing the total quantity of cement into two batches, each of from 150 to 200 sacks. The first batch, which is pumped into the well between a set of special plugs, is placed around the shoe. The second batch, pumped into the well between a regular set of cementing plugs, is forced out through a set of valved outlets in the casing about 100 feet below the artesian water sand, which is at a depth of approximately 1,000 feet. The valved outlets in the casing are controlled by the cementing plugs, by which means two cementing jobs are carried out on a single string of casing. In all, 180 sacks cement were placed around the shoe and 225 sacks placed through the multiple stage cementing device, which was about 900 feet down the casing. The complete job took only one hour and ten minutes.

Later, the well was tested under the usual pressure requirements as set forth by the city authorities of Gladewater, and the job passed as successful. The well was then brought in, since which time it has been producing satisfactorily.

Officials of the Humble Oil and Refining Company in charge of the well were Frank Bass, assistant division superintendent; Tom Bounds, field superintendent, and B. R. Gossett, tool pusher. The city officials already mentioned were also represented at the well.

On the successful outcome of this first well cementing job by the new process, the city authorities of Kilgore agreed to allow the trial use of the method on a well. Accordingly, a well of the Humble Oil and Refining Company was cemented by this method in the Kilgore area on February 26, 1932. On this well a Halliburton full hole cementer was run as well as the multiple stage cementing device, and a total of 375 sacks cement was placed in two batches, one through the full hole cementer and the other through the valved outlets in the multiple stage cementing device, in a total elapsed time of 56 minutes. In charge of this well were Frank Bass, assistant division superintendent; L. C. Peters, field superintendent, and Charles Hatcher, tool pusher, of the Humble Oil and Refining Company.



for DEEP WELLS
RELY ON THIS STRONG
DURABLE, UNIFORM TUBING

Deeper and deeper wells, longer strings of tubing, harder conditions of service everyway, impose new tests on the character of oil well tubing nowadays.

By the correctly balanced design of NATIONAL A.P.I. External Upset Tubing, severe bending stress is distributed, crushing action of couplings is resisted and additional wearing metal is given at the joint. The seamless walls and heavy upset ends afford extra strength just where it is needed and extra security where a string might otherwise be vulnerable.

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America's Preferred Tubing

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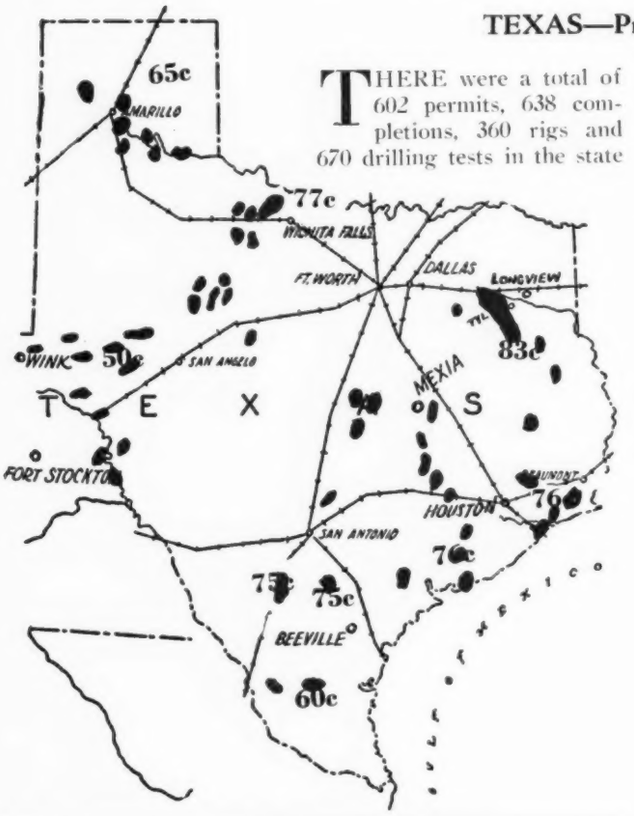
US STEEL

NATIONAL-SEAMLESS EXTERNAL UPSET TUBING

Latest Activities *in the* Oil Fields*

TEXAS—Production, 1931—330,720,000 Barrels



THERE were a total of 602 permits, 638 completions, 360 rigs and 670 drilling tests in the state of Texas for the month of February. The majority of work in the state continues to be in East Texas, where activities are not slowing up very rapidly. This great pool is accounting for more than half of the oil field operations in the state. A slight increase in East Texas operations was due to better road conditions which permitted transporting of equipment.

A tabulated report of several fields follows:

	POOLS			
	East Texas	Panhandle	Van	Refugio
Number of Permits	387	9	11	2
February Completions	398	10	7	2
Number of Rigs	80	15	2	1
Number Drilling Wells	592	29	16	1
Gravity of Oil	40	40	36	26
Depth of Production	3600	2900	2600	6500
Type of Tools Used	Rotary	Rotary	Rotary	Rotary
Number of Casing Strings	2	2	2	3

CALIFORNIA

Production, 1931—188,575,000 Barrels

There were 25 new drilling permits or locations made in California during February, during which time 26 tests were completed. The state has 16 rigs and 138 drilling wells.

Activity in the state continues to be quite routine, with all promising areas heavily regulated as to both drilling and production.

Following is a survey of some of the more active fields:

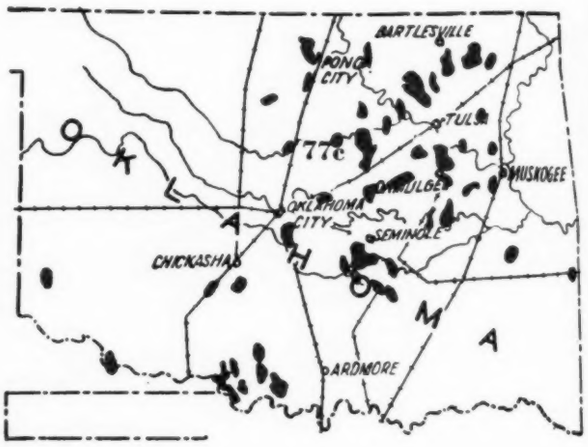
	POOLS			
	Playa Del Rey	Long Beach	Kettleman Hills	Ventura
Number of Permits	1	0	3	1
February Completions	2	8	0	1
Number of Rigs	1	0	2	1
Number Drilling Wells	2	7	11	3
Gravity of Oil	23	26	60	36
Depth of Production	6000	7000	8300	7800
Type of Tools Used	Rotary	Rotary	Rotary	Rotary

*All statistics as of March 1st.

●Denotes oil and gas fields.

OKLAHOMA

Production, 1931—177,750,000 Barrels



There continues to be practically no important field operations in Oklahoma. Oklahoma City is still the most active area.

Following is a summary of Oklahoma's activity:

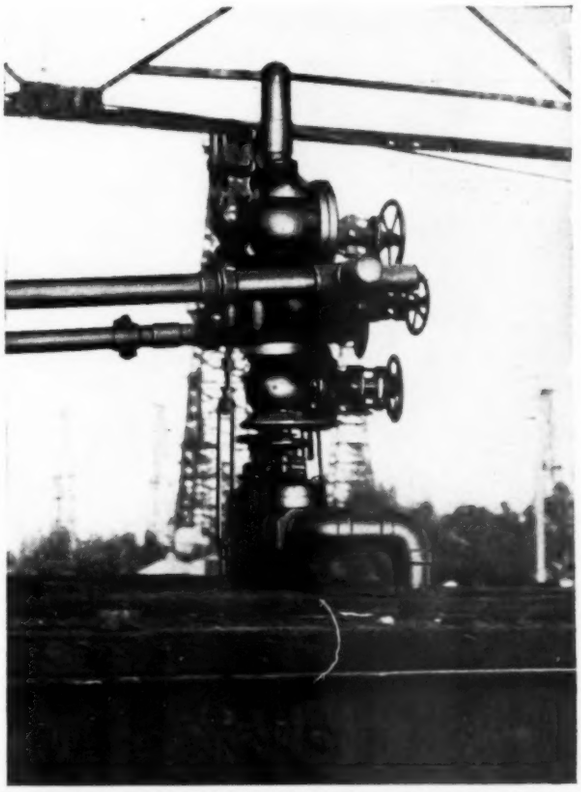
	Entire State	Oklahoma City
Number of Permits	82	11
February Completions	78	13
Number of Rigs	46	13
Number of Drilling Wells	116	29
Gravity of Oil	36 (average)	39
Type of Tools Used	Rot.-Cab.	Rotary
Number of Casing Strings	Varies	3
Depth of Production	Varies	6500

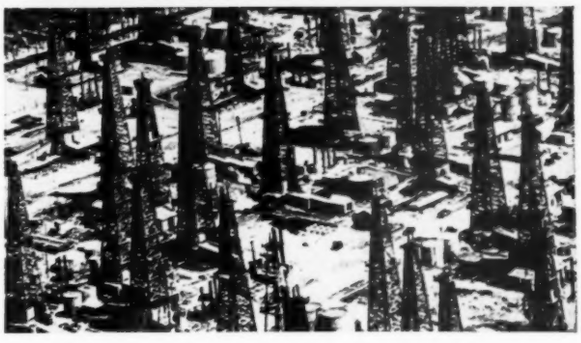
Figures on maps indicate average prices of crude oil per bbl.

HAYSTELLITED BIT *drills* 1,312 *feet*

without redressing

"Christmas trees" grow faster where drilling tools are protected with Haystellite and Haystellite-Composite Rod.





A 12-in. bit set with Haystellite and faced with Haystellite-Composite Rod drilled 1,312 feet near Damon, Texas, and was only 1/8 in. out of gauge when pulled.

At Overton, a bit set and faced with Haystellite made 1,286 feet without redressing.

Amazing as these records are, they are in no way exceptional. Your bits can do the same if you protect them with Haystellite and Haystellite-Composite Rod.

Haystellite is a cast tungsten-carbide alloy which combines great hardness with toughness sufficient to resist the impact of drilling. Haystellite-Composite Rod is crushed Haystellite evenly distributed in a tough steel binder. The crushed Haystellite has the same excellent physical properties as Haystellite inserts and produces a uniformly hard cutting edge.

Haystellite and Haystellite-Composite Rod can be applied by welding to practically all types of drilling tools. If you are interested in drilling straighter holes faster and at lower cost, write today for further information.

HAYSTELLITE TRADE MARK

The cast Tungsten Carbide diamond substitute

HAYNES STELLITE COMPANY

Unit of Union Carbide and Carbon Corporation

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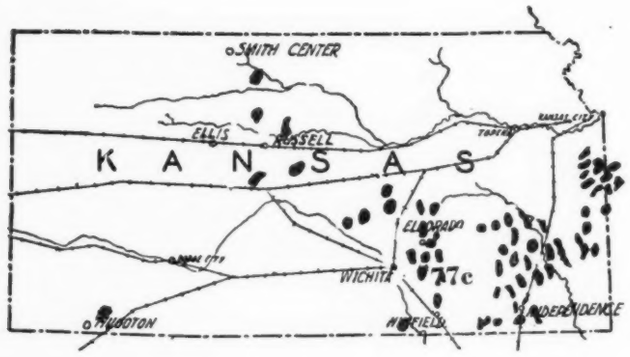
Haynes Stellite products are available also through the 42 apparatus shipping points of The Linde Air Products Company

KANSAS—Production, 1931—37,950,000 Barrels



Thirty-five new drilling permits were issued in Kansas last month, while 44 tests were completed. There are 25 rigs and 66 drilling tests in the state. Both rotary and cable tools are used in the state, with the latter the most common.

Following is a report of the activities in the three active spots of the state:

	POOLS		
	Sedgwick County	Ellsworth Arch	McPherson County
Number of Permits	5	6	5
February Completions	5	8	10
Number of Rigs	2	4	11
Number Drilling Wells	6	8	22
Gravity of Oil	39	37	38
Depth of Production	2900-3500	3300	2900-3400
Type of Tools Used	Rot.-Cab.	Cable	Rot.-Cab.
Number of Casing Strings	2	4	2

ARKANSAS

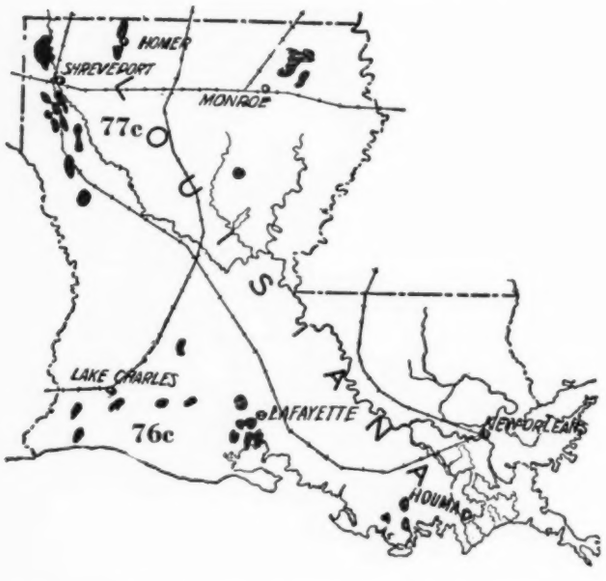
Production, 1931—15,425,000 Barrels

There were 8 rigs and 27 drilling tests in the state of Arkansas at the end of the month of February. The state had no completions or permits made during the month.

Rotary type tools are used by contractors for drilling purposes in the state, where formations frequently carry large gas pressures and are usually soft and cavey.

LOUISIANA

Production, 1931—22,325,000 Barrels



Louisiana has 22 new drilling permits, 29 completions, 18 rigs and 73 drilling wells for its oil field activities during February. Rotary tools are operated in both the Gulf Coast and North Louisiana areas.

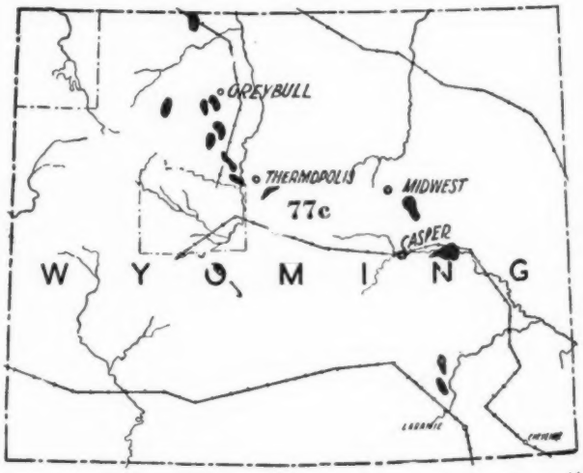
In Mississippi, adjoining neighbor state of Louisiana, there were 6 completions, 10 rigs and 9 drilling operations. The activity of this state is centered around the Jackson gas region.

● Denotes oil and gas fields.

WYOMING

Production, 1931—14,725,000 Barrels

There were 2 completions, 12 rigs and 61 drilling tests in Wyoming last month. Practically all the tests in this state are drilled with cable tools.



Figures on maps indicate average prices of crude oil per bbl.

NEW YORK

Production, 1931—3,400,000 Barrels

PENNSYLVANIA

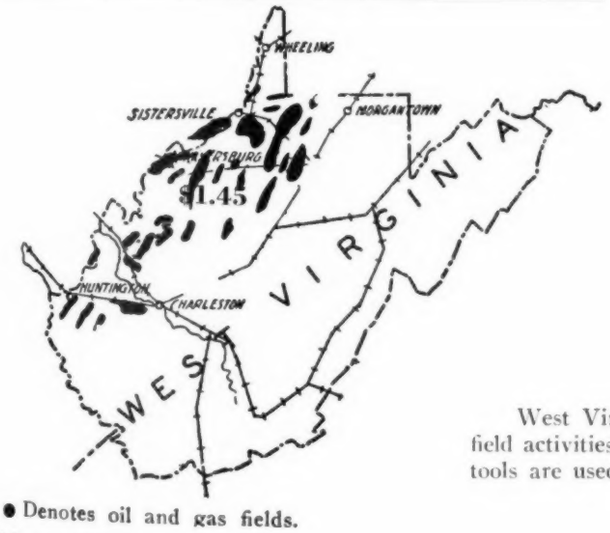
Production, 1931—11,225,000 Barrels

There were 38 completions in New York last month, while Pennsylvania had 84 tests finished. The two states have a combined total of 19 rigs and 90 drilling tests, all of which are standard type tool rigs.

ILLINOIS

Production, 1931—4,850,000 Barrels

A total of 6 completions were made in the state of Illinois during the month of February. A total of 17 tests were drilling and but 1 rig was located in its oil fields. Standard tools are used by operators to drill for oil in Illinois.

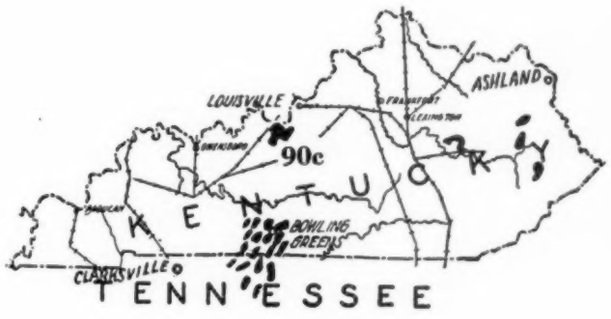


● Denotes oil and gas fields.

KENTUCKY

Production, 1931—6,490,000 Barrels

The state of Kentucky had 36 completions, 5 rigs and 67 drilling tests last month. Tennessee, with no completions nor rigs, had 14 drilling tests. Cable tools are used for drilling purposes by operators of both states.



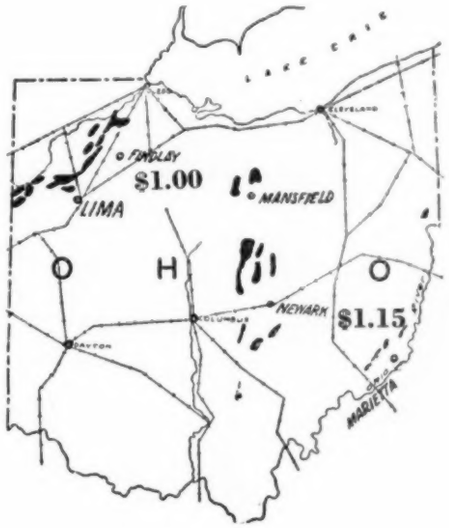
TENNESSEE

Production, 1931—8,000 Barrels

OHIO

Production, 1931—5,315,000 Barrels

The state of Ohio had 73 completions during February, while 114 tests were drilling and 35 operations were listed as rigs. Cable tools are utilized for all drilling operations in the state, where the producing horizons are comparatively shallow and easily reached.



WEST VIRGINIA

Production, 1931—4,480,000 Barrels

West Virginia had a total of 35 completions last month. Other oil field activities were comprised of 15 rigs and 43 drilling tests. Standard tools are used for drilling purposes in the state.

Figures on maps indicate average prices of crude oil per bbl.

NEW MEXICO

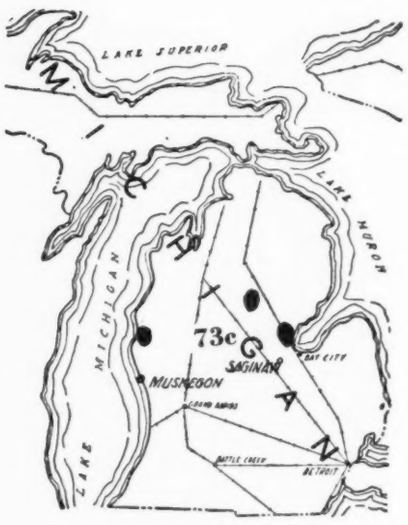
Production, 1931—15,250,000 Barrels

A total of only 2 completions were made in the state of New Mexico during the month of February, at the close of which time there were 5 rigs and 45 drilling tests in the state.

Both rotary and cable tools are used in the state, with the former predominating in number. Rotaries are used primarily in the southeastern section of the state, where producing horizons are around 4000 feet in depth and where heavy-pressure upper horizons are encountered.

MICHIGAN

Production, 1931—3,730,000 Barrels



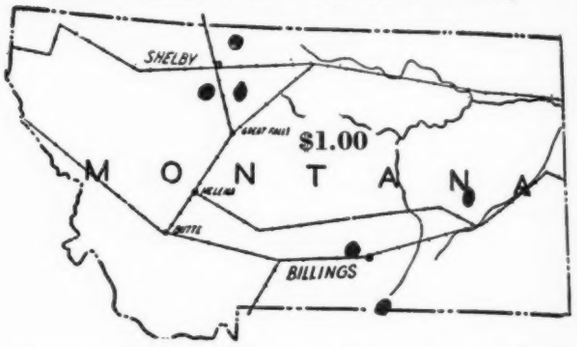
There were a total of 7 oil tests completed in the state of Michigan during the month of February. This state at the end of the month had a total of 58 rigs and 81 drilling tests within its boundaries.

Operators of this state do their drilling with cable tools, except in a few instances where rotary tools have been used.

● Denotes oil and gas fields.

MONTANA

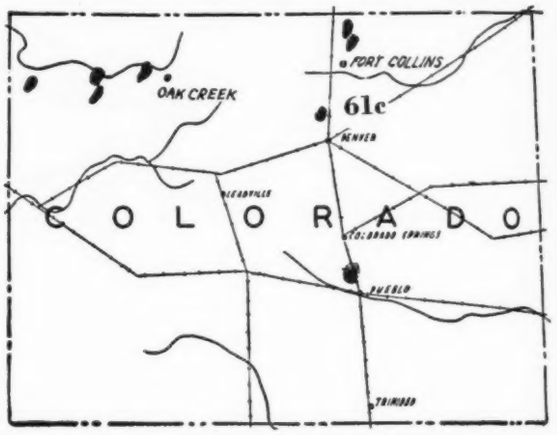
Production, 1931—2,855,000 Barrels



Montana had 6 completions, 13 rigs and 48 drilling tests for last month's activity. Cable tools are the most common means of making hole in the state.

COLORADO

Production, 1931—1,510,000 Barrels



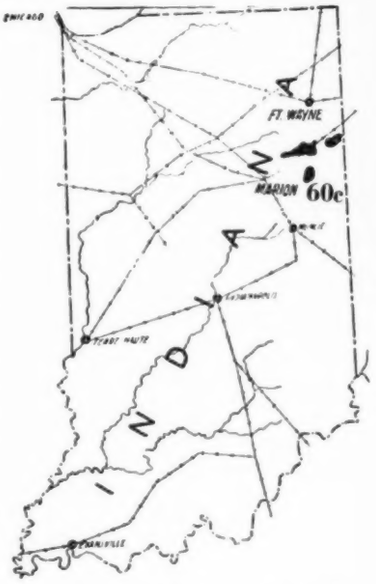
Five completions, 11 rigs and 70 drilling tests comprised Colorado's oil field operations during the month of February. Both rotary and cable tools are used here.

INDIANA

Production, 1931—830,000 Barrels

The state of Indiana had a total of 20 completions in its oil fields during the month of February, as compared with 8 the previous month. Other oil field activity consisted of 4 rigs and 41 drilling tests.

Drilling operations in the state are conducted with standard type tools. The producing horizons are shallow and are easily reached.



Figures on maps indicate average prices of crude oil per bbl

"Hercules" (Red-Strand) Wire Rope Drills World's Deepest Cable-Tool Well

At left is Mr. L. L. Windom, Division Superintendent for the United Fuel Gas Company, who has drilled the world's deepest cable-tool well. At right is A. H. Poulson, Leschen representative.

"100 Per Cent Satisfactory"

—Writes Division Superintendent

The United Fuel Gas Company of Charleston, W. Va., holds the record for drilling the world's deepest cable-tool well. Mr. L. L. Windom, Division Superintendent for that company, wrote us under date of January 15, 1932, as follows:

> *"Leschen rope has been used exclusively in the drilling of the deepest cable-tool well on record, which is now 9,085 ft. deep, and we are in hopes of drilling considerably deeper than 10,000 ft. Drilling at this depth requires the very highest quality rope and your 'HERUCLES' (Red-Strand) Rope has stood what I would call the acid test. The performance of this high-class rope has been 100% satisfactory and I gladly recommend it to the oil and gas trade in general as a most serviceable proposition."*

"HERCULES" (Red-Strand) Wire Rope is furnished in Rotary Lines; Cable-tool Lines; Casing Lines; and Sucker-rod, Swabbing and Tubing Lines. Do you not want to use wire lines that have "Stood the acid test"? Why not ask us or our nearest distributor for further particulars?

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Progress of Major Pipe Line Work

By J. H. DAMERON

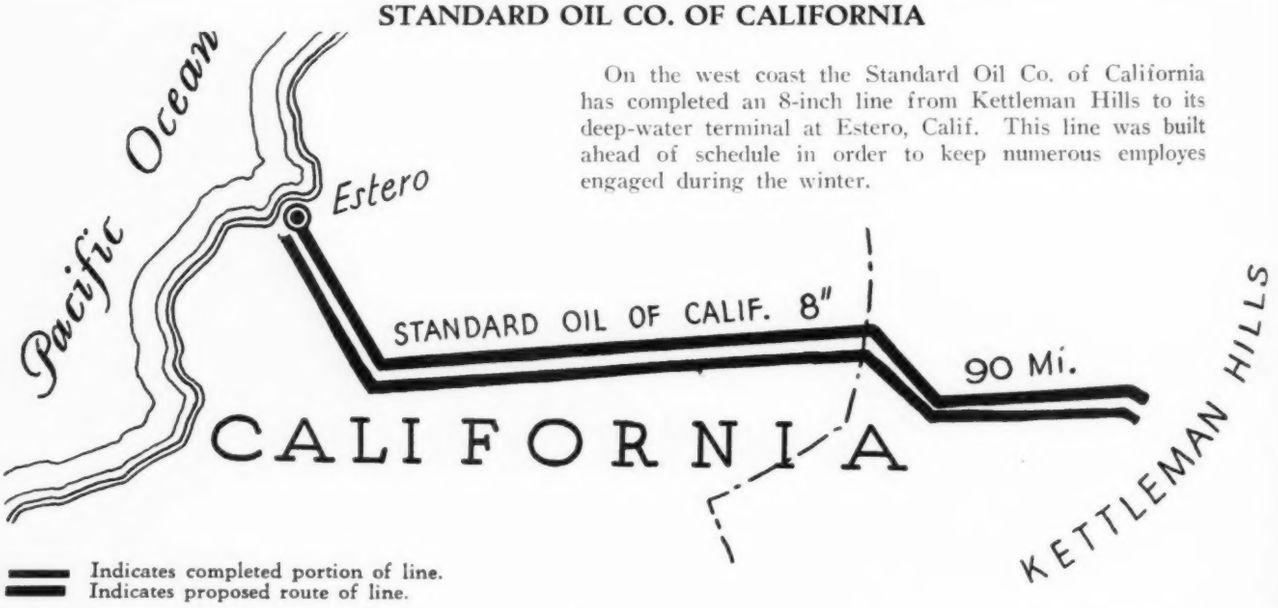
AS pipe line construction sagged to its lowest level in months, final plans were in the making early in March for the resumption of lateral line work on several gas lines. Some of this work is being held up by legal obstacles, while other is delayed by right-of-way difficulties. In the northwest considerable activity is being shown by various concerns in obtaining franchises and permits to build transmission systems. Some of these concerns have plans, contingent upon franchise proposals, to start construction work in the spring.

Announcements dealing with the expansion of existing gasoline lines may be made soon. One company operating in the Mid-Continent is reported planning to accept additional runs from three refining companies and a line in the East is expected to be extended this spring.

The Arkansas Pipe Line Co., Shreveport, La., has completed its work in connection with cleaning an old oil line built by The Texas Pipe Line Co., from Shreveport to Port Arthur. The company is transporting gasoline from the Louisiana Oil & Refining Co.'s Bossier refinery at Shreveport to Port Arthur.

STANDARD OIL CO. OF CALIFORNIA

On the west coast the Standard Oil Co. of California has completed an 8-inch line from Kettleman Hills to its deep-water terminal at Estero, Calif. This line was built ahead of schedule in order to keep numerous employes engaged during the winter.



Indicates completed portion of line.
Indicates proposed route of line.

ON 15 major pipe lines completed in East Texas, 50 per cent. of the total oxy-acetylene welded mileage is Lindewelded.

Why, in scarcely more than a year, has this new method of oxy-acetylene welding been adopted by leading pipe line builders in every part of the country?

The answer is: Because it saves from 30 to 60 per cent. of the time required by ordinary methods of welding.

Because it reduces welding material consumption 35 to 40 per cent. Because it produces stronger joints.

Lindewelding can be done with ordinary blowpipes or with special apparatus which makes welding almost automatic and further increases its speed. Experienced welders quickly master its special technique; beginners learn it more readily than other methods.

Procedure Controls for Lindewelding are available to all users of Linde Oxygen as a part of Linde Process Service. Ask our nearest district office for full particulars.

Motion Picture Shows details of Lindewelding

Lindewelding technique differs from neutral flame welding technique in that it employs a special rod, a special flame adjustment, and the "backhand" method of blowpipe manipulation. The actual steps in making a Lindewelded joint are shown in our motion picture, "The Lindeweld Process for Pipe Line Construction". This picture will be loaned free of charge to pipe line officials and welding or engineering societies. It is furnished in 16 mm. and 35 mm. safety film and can be obtained by writing to any Linde District office.

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PIPE LINES UNDER CONSTRUCTION AND CONTEMPLATED

Type Line	Company Name	Headquarters	Point of Origin	Terminal	Size Pipe	Length in Miles	Remarks
Ga.L.	Atlantic Refg. Co.	Philadelphia, Pa.	Point Breeze	Wilkes-Barre, Pittsburgh	6-8"	475	Part of system operating. Plan extension of main line this year.
G. L.	Bivens, C. E., et al.	Laramie, Wyo.	Baggs Field	Laramie, Wyo.	12"	104	Plan to build in 1932.
G. L.	Big Bend Pipe Line Co.	Ft. Stockton, Tex.	(See Remarks)				Plan to extend present system with 60 miles of 4-inch.
G. L.	Columbia Gas & Elec. Co.	New York, N. Y.	Ky. or Pan Eastern Line	Detroit, Mich.	20"	220	Considering going to Detroit, Mich., with line and to Toledo.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Chicago, Ill.	Detroit, Mich.	20"	200	Plan extension of Panhandle line to Detroit.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Point in Ill.	Milwaukee, Wis.	20"	160	Buying right of way.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Texas Panhandle	Chicago, Ill.	24"	1000	Plan to start parallel present line in 1932.
O. L.	Continental Oil Company	Ponca City, Okla.	Greasewood Flats, Colo.	Denver, Colo.	6"	70	Proposed—Held in abeyance.
G. L.	Cities Service, Insull, Texas Corp. & S. O. N. J.	(See Remarks)					Rumored considering building 1,500-mile project from Panhandle to Eastern cities.
Ga.L.	Great Lake Pipe Line Co.	Kansas City, Mo.	Okla. Midcontinent	Great Lakes Region	4-6-8"	1440	Considering increasing station capacity this spring.
O. L.	Gulf Pipe Line Co.	Tulsa, Okla.	Tulsa, Okla.	Spencerville, Ohio	10"		Plan looping present line and increasing station capacity.
G. L.	International Util. Corp.	New York, N. Y.	Alberta, Canada	Vancouver, B. C.	20"	500	Proposed.
G. L.	Jerome Drumheller	Spokane, Wash.	Cut Bank, Wyo.	Seattle, Wash.	20"	500	Proposed.
G. L.	Lycoming Nat. Gas. Corp.	New York, N. Y.	Tioga Field, N. Y.	Syracuse, N. Y.			Plan to extend main line from Syracuse to Oswego with 38 miles of 16-inch.
G. L.	Lewiston Nat. Gas Co.	Lewiston, Mont.	Armells Structure, Mont.	Mont. towns	4-6"	100	Proposed.
G. L.	Mid-Continent Public Service Co.	Fort Scott, Kan.	Field near Chanute	Fort Scott	8"	28	Moore-Creekmore Const. Co., Tulsa, have contract to build upon completion of plans.
G. L.	Missouri Valley P. L. Co.	Omaha, Neb.	Point in Minnesota	Minneapolis, Minn.	16"		Proposed.
G. L.	Montana-Dakota Power Co.	Minneapolis, Minn.	Williams, N. D.	Minot, N. D.	12"	100	Applied to N. D. Commission for permission to build.
G. L.	Mo.-Kans. Pipe Line Co.	Chicago, Ill.	Russellville, Ky.	Nashville, Tenn.	10"	50	Proposed.
G. L.	Ohio Oil Company	Findlay, Ohio	Weiser Field, Idaho	Boise and Northwest area			Filed application for conveyance certificate.
G. L.	Pacific Gas & Elec. Co.	San Francisco, Calif.					Have appro. for $2,000,000 expansion campaign.
G. L.	Panhandle Eastern P. L. Co.	Kansas City, Mo.	(See Remarks)				Reported planning 200 miles of lateral line construction in Missouri and Illinois.
O. L.	Stanolind Pipe Line Co.	Tulsa, Okla.	Mid-Continent	Chicago, Ill.	8-10"	360	Hoop work complete, finishing station work.
Ga.L.	Sun Pipe Line Company	Philadelphia, Pa.	Point in N. Y.	Lake Ontario	6"	45	Extending to tidewater terminal.
G. L.	Southern Nat. Gas Corp.	Birmingham, Ala.	(See Remarks)				Reported planning extension to Chattanooga, Tenn.
G. L.	St. Louis Industrial Fuel Co.	St. Louis, Mo.	(See Remarks)				Plan to enter St. Louis for industrial loads with line from southwest.
O. L.	Texas Empire Pipe Line Co.	Tulsa, Okla.	Okla. City, Okla.	East Texas	10-12"	250	Pur. right of way for oil line to East Texas
O. L.	Tex-York Utilities Corp.	New Orleans, La.	East Texas	New Orleans, La.	8"	400	Proposed.
G. L.	United Public Service Co.	Houston, Texas	Austin	Wichita Falls	20"	240	Rumored plan extension of main line system.
G. L.	Wasatch Gas Company	Ogden, Utah	Ogden, Utah	Pocatello, Idaho	10"	140	Applied for permit to build welded line.
O. L.	Yount-Lee Oil Company	Beaumont, Tex.	High Island	Spindletop	10"	45	Completed.

TABLE

O. L.—oil line Ga. L.—gasoline line
G. L.—gas line

The stem turns to open like any plug cock... BUT... the plug LIFTS before it turns

The New CHAPMAN Lubricated PLUG COCK

In this new Chapman cock the plug is, of course, tapered, lapped with its seat. Turning of the stem to open, first transmits an almost irresistible screw-jack lifting action to the stem, sufficient to break any seal. *Then*, with plenty of clearance, the plug turns easily.

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The Month's Activities *in* Refining*

By F. R. STALEY

CRUDE runs in Eastern and Western refineries increased slightly over the previous month, and decreased in the Central division.

The Western Petroleum Refiners will hold their annual convention at Excelsior Springs, Mo., April 6, 7 and 8.

The Hope Engineering Corp. has contracted with the Universal Oil Products Co. to convert the Leamon cracking unit of the North-west Stellarene Co. at Coutts, Alberta, into a 1,200-barrel Dubbs cracking unit.

The American Tank & Equipment Corp. recently completed a heavy pressure vessel and welding job for the Octane Oil Refining Co. of Chautauqua, Texas, to be installed in the latter's 1,400-barrel refinery under construction.

Arthur G. McKee & Co. announced a million-dollar refinery near Hanover, Germany, for the Elwerath Gewerkschaft. It is a 2,600-barrel refinery, and includes a Dubbs cracking unit.

Alco Products Co. is building a 4,000-barrel Stratford treating plant for the Continental refinery at Fairfield, Md.

The Shell Petroleum Corp. will install additional cracking units at its Deer Park refinery near Houston, Texas.

The La Porte Oil & Refining Co. is planning a 2,500-barrel refinery at La Porte, Texas.

The Hartman Interests are planning a refinery to be built near Beaumont, Texas.

The Alco Products, Inc., is building a stabilizing and recovery plant for the Garber Refining Co.

Soars and Lovelace, Inc., is building a stabilizing and recovery plant for the El Dorado Refining Co.

The Champlain Refining Co. will build a stabilizing plant at Enid, Okla.

The Winkler-Koch Engineering Co. is building a stabilizing plant for the Standard Oil Co. of Kansas at Neodesha.

The Marathon Oil Company will install a new cracking unit at Bristow, Okla.

The Alco Products Company will build an asphalt-vacuum unit for the Skelly Oil Company at El Dorado, Kan.

The Sterling Refining Company will operate the Peerless refinery on the north end of the Oklahoma City field. It is a 2,000-barrel plant.

Dr. F. T. Gardner of the University of Tulsa discussed the use of magnesium hydroxide in petroleum refining at a meeting of petroleum chemists in Okmulgee, Okla., February 27.

Natural Gasoline

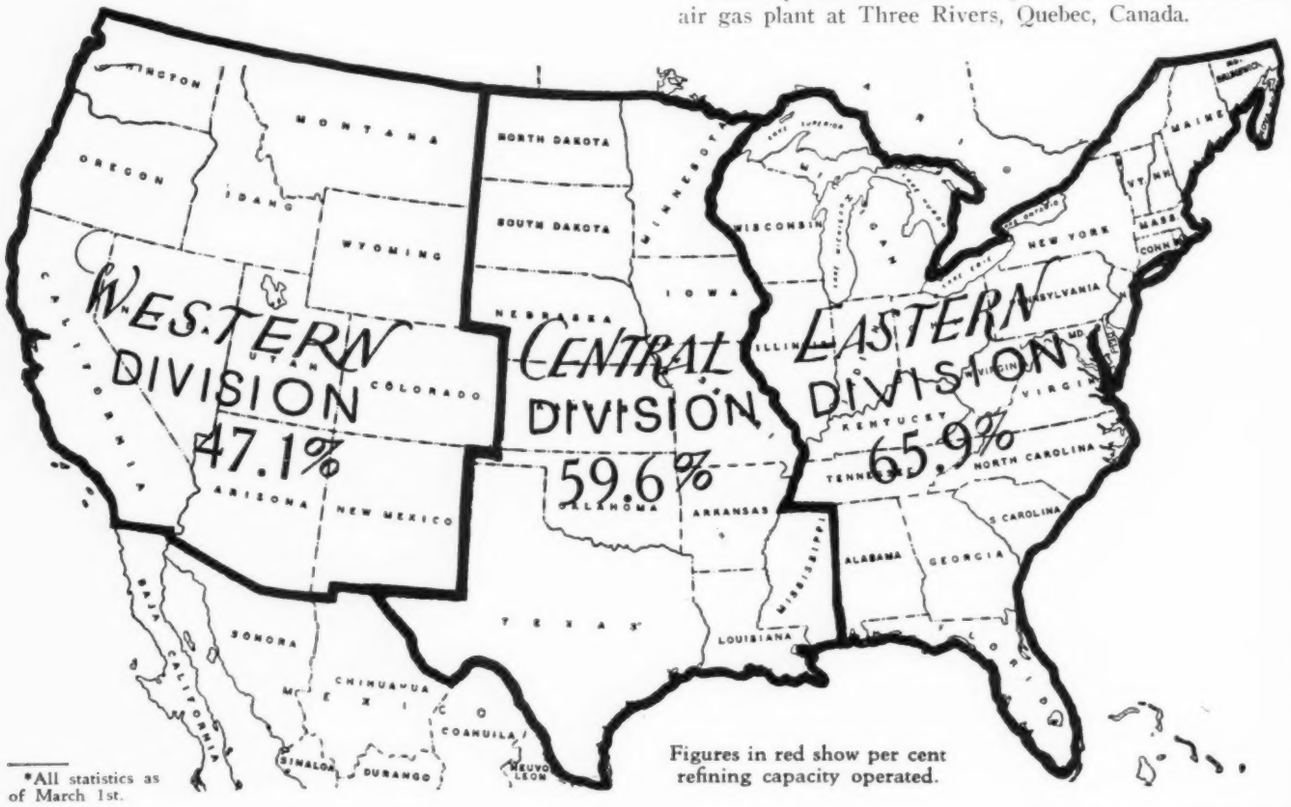
The Natural Gasoline Association of America will hold the Ranger District Plant Operators' meeting at Ranger, March 29. An excellent program has been arranged for the annual convention in Tulsa, beginning May 17-18-19.

An air-butane plant was just completed at El Centro, Calif., by the Natural Gas Corp. of California.

Pacific Producers, Inc., Los Angeles, Calif., is planning to serve air butane and vapor systems to 30 cities in Idaho.

The Suburban Gas Co., Belvedere, N. J., is completing a propane plant for Belvedere.

The City Gas & Electric Corp., Ltd., will erect a butane-air gas plant at Three Rivers, Quebec, Canada.

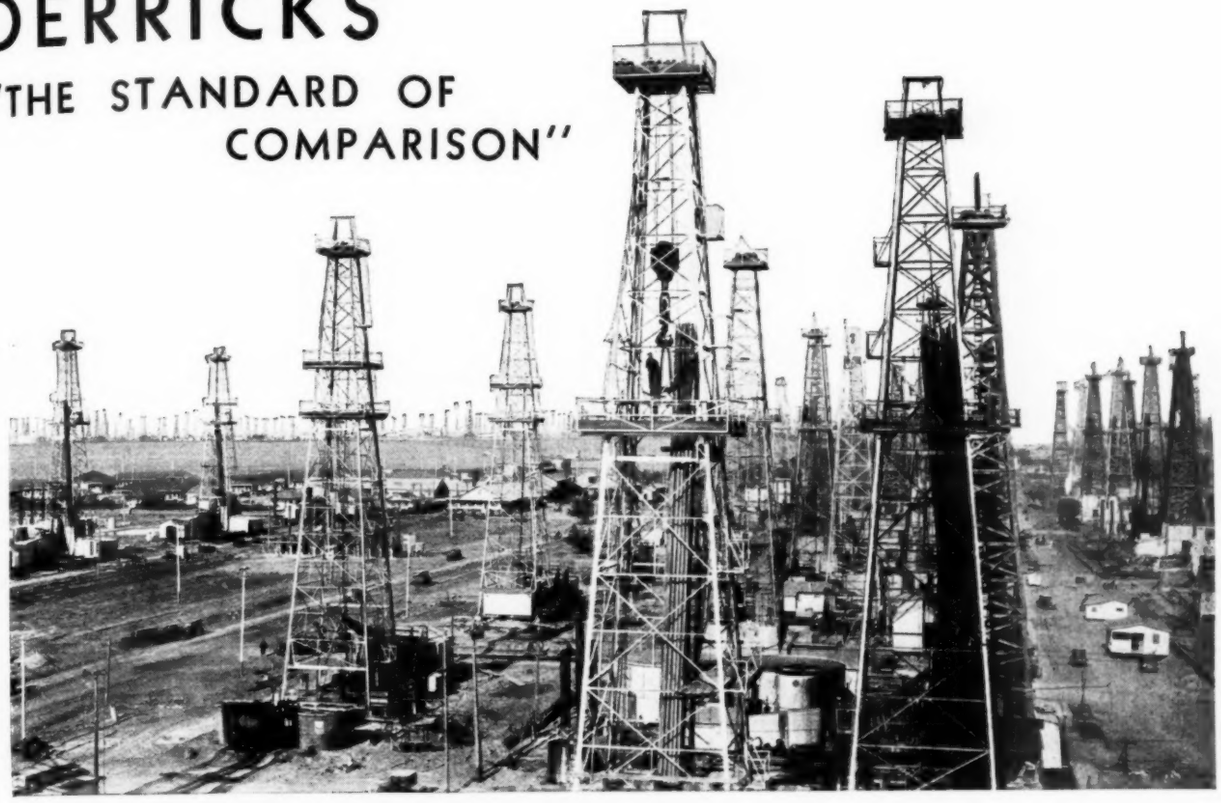


Figures in red show per cent refining capacity operated.

*All statistics as of March 1st.

IDECO DERRICKS

"THE STANDARD OF COMPARISON"



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The MANUFACTURE of REFRACTORY BRICK

By GEO. P. REINTJES*

A North Central Missouri open pit clay mine.

REFRACTORY clays are found in various forms throughout the world, in the form of alluvial deposits. In the course of the writer's experience as a furnace mason contractor he has visited most of the refractory plants in the central part of the United States, especially those in Missouri and Colorado. In these states are clay deposits of the highest quality.

The Missouri clays that have found the most favor in the oil industry are of the semi-flint nature. They are mostly mined in North Central Missouri.

Even in North Central Missouri there is a wide difference in the uniformity of the clay deposits. These clays are deposited in beds ranging from 5 feet to 50 feet in thickness, and vary from 10 feet under the ground at the west end of the deposit to over 100 feet below the surface at the east end of the area. Parts of the area underlying the refractory clays are very rough and hilly, while other sections are comparatively level.

The common theory is that the refractory clay deposits were made during the glacier period, the clays being carried down from the Mesabi Range and deposited. These deposits were made after the hills and valleys were formed, as the clay deposits follow the contour of the ground. The deposits were apparently made at several periods, the first quality clays being in the lower strata and the lower quality clays are in the upper strata. When the deposits were made in the hilly sections, possibly due to eddying, the purer clays were deposited in the smaller ravines or valleys and the clays not so free of impurities were deposited in the broader valleys. This is comparable to coarse and fine gravel beds in a river stream.

Number one quality Missouri clays are very light in color, whereas the second quality clays range from a darker shade to almost black. The number one quality or the lighter colored clays range from a pure flint clay to those of a semi-flint nature. Where the pure flint clays are encountered, bonding clays are added. Another method commonly used where there is a deficiency of bonding clays is to allow the brick to remain under pressure in the dry press machine for a longer period to assist in tying the particles together. It has not been found commercially practical to make a pure flint brick that will withstand the strains of shipping and handling.

The proportion of second quality clays to first quality clays in the deposits is not constant, but varies very materially. They may range from 20 per cent second quality and 80 per cent first quality to 60 per cent second quality and 40 per cent first quality within a few feet of each other.

For this reason, and also due to the beds following the contour of the hills, where the overburden is not excessive it has been found much more practical to procure the clays by removing the overburden, taking out the second quality clays and then the first quality clays, using methods similar to strip coal mining.

Where the overburden ranges from 60 to 100 feet, re-

*Geo. P. Reintjes Co.

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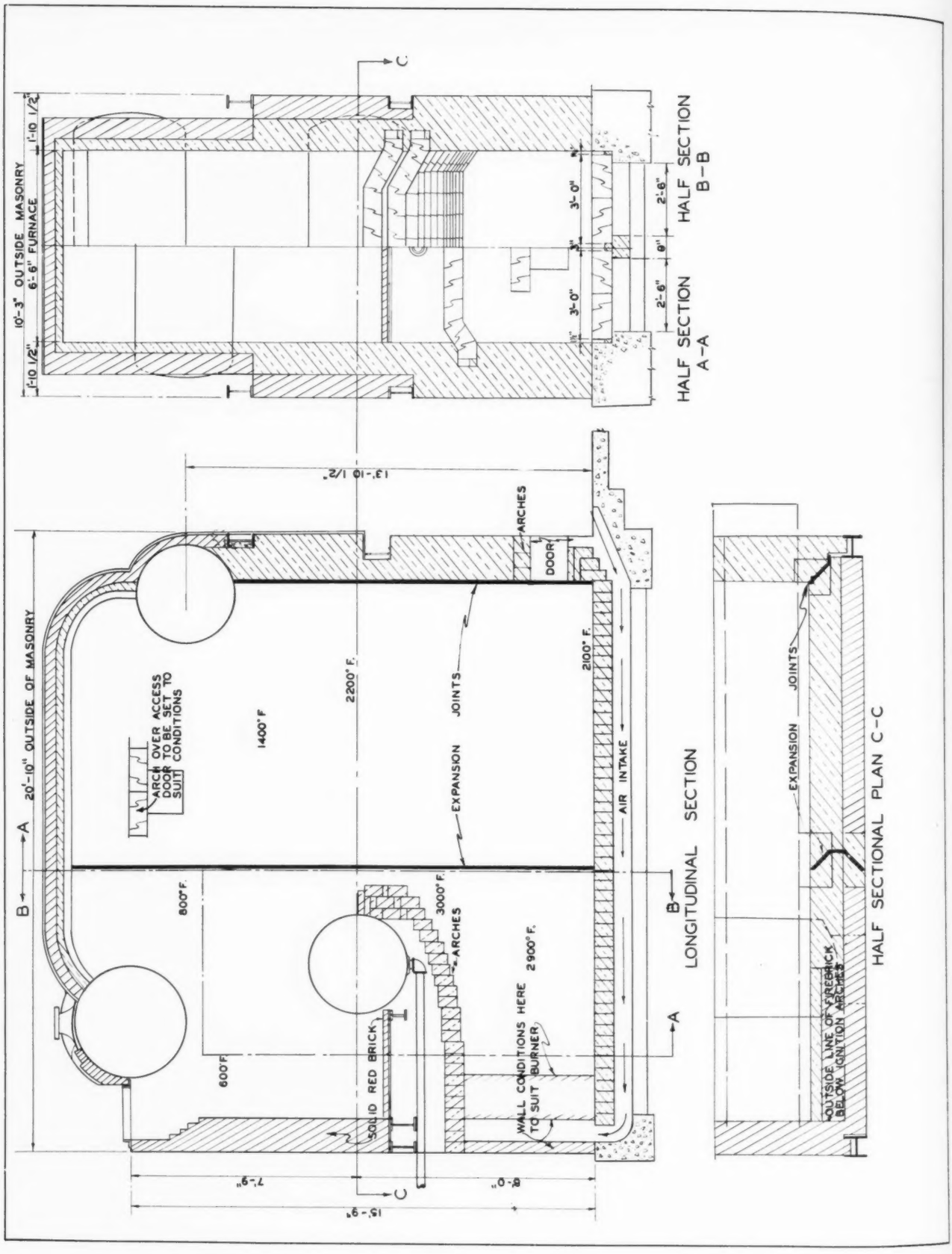

course must be had to the shaft and room methods of mining. A formation of coal ranging from a few inches to several feet in thickness almost invariably overlies the clays in the deeper deposits and is left there to form a roof when mining. The room and shaft method of mining is only practical where the contour of the land is comparatively level.

Considerable ingenuity is required when removing the clays by the room method to keep the first and second quality clays separated, as well as to keep the roof coal out of

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The same integrity and exactness which have always gone into NATIONAL products for the uncompromising demands of many industrial uses are now applied to the series of U S S Chromium-Nickel Alloy Pipe and Tubes.

Effective resistance to corrosion, unusual ductility, and improved strength at high temperatures characterize this scientifically made, fully annealed, austenitic steel. NATIONAL engineers, metallurgists, and laboratory technicians are at the service of Refinery designers and operators to aid in determining the best application of Stainless and Heat Resisting Steel Pipe and Tubes to any particular requirement.

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the clays. It is imperative that the two qualities of clays be separated, not only because of their difference in service, but principally because the difference in their shrinkage when burned would not make a uniform brick.

On the other hand, the open pit is subject to rains and the moisture content will vary, requiring more watchful care on the part of the plant operators. Here again some manufacturers mining their clays by the open pit method have large storage bins entirely enclosed from the elements where they can blend and dry their clays to an absolute uniformity.

The Colorado clays, principally those found west of Denver, are more easily mined. While they were originally deposited in horizontal layers with the lower quality clay on top, a prehistoric eruption up-ended them so they are now lying slightly less than 20 degrees off vertical. The principal deposits have an average of about 4 feet of second quality clay and 8 feet of first quality clay. The up-ended deposits rise about 450 feet above the ground surface and are several miles in length.

In mining the clays, a tunnel was drifted into the side of the hill to the deposit and then turned to follow the vein. The number one clays only are mined. When sufficient head room is mined the number two clays are propped against falling. Planks are then placed on a row of braces, forming a storage bin for the clays excavated above the roof. Trap doors in this covering release the clays to the cars below. Due to the absence of moisture, the use of the trap system, and the lack of overburden to be removed, the clays are mined very economically.

The principal refractory companies in Missouri use similar processes and equipment in the treatment and manufacture of the brick; namely, the clays after leaving the mine or pit are ground to the desired fineness for the particular brick, blended with other clays or with a proportion of calcined clays to control the shrinkage, compressed in a dry press machine and burned in a tunnel kiln.

Colorado manufacturers have always used the beehive or similar kilns to burn their brick. However, the Denver Fire Clay Company will soon install a tunnel kiln similar to those used in Missouri.

Among the Missouri manufacturers who use methods similar to those mentioned herein are General Refractories Company, A. P. Green Fire Brick Company, Harbison-Walker Refractories Company, Laclede-Christy Clay Products Company and Mexico Refractories Company.

Due to the variation of the shrinkage in the clays as they are mined, the different proportion of bonding clays to the flint clays, and the varied moisture content, great credit for uniformity in brick must be given to the plant operator and the plant ceramist. The best of clays can be spoiled in the plant, so that for practical purposes the chemical constituents are in many cases of secondary importance as compared with the human element manufacturing the brick.

The manufacturers change their "mix" in making different brick to meet the various services encountered. Unfortunately, no all-purpose brick has as yet been developed. Each manufacturer makes several kinds of bricks from the same clays, having different characteristics.

The finely or coarsely ground clays make a dense or an open-textured brick. Less spalling is encountered with an open-textured brick. A dense brick, however, will resist the slagging actions from fuels.

Brick that have a fusing point of 3300 degrees F. in an electric furnace will frequently fail below 2200 degrees F. in service.

In other words, from the contractor's point of view, the physical structure of the brick is of far more importance in the life of the furnace than its chemical composition.

Fire brick burned in a tunnel kiln are more uniform and more thoroughly burned than is possible in a beehive or other type of periodic kiln. Tunnel kiln brick are free from kiln marks; that is, deformations in the side of the brick due to the weight of other brick, as is the case when the brick are piled in large quantities and to greater heights, as in the periodic kilns.

The color of the brick is no indication as to the quantity of iron or other impurities in the brick. The color can be controlled from an almost pure white to a mottled or brown color, simply by increasing or decreasing the amount of air used for combustion when burning the brick, or by the amount of sulphur in the fuel oil used in firing.

The same advantages that are to be found in making standard fire brick by the dry press are more pronounced in the making of special shapes. We have found that when our own shapes were made by the hand method, twisting, warping and checking from uneven drying occurred. Also where there were a number of angles in the shapes, laminations or cross-grained structures occurred that would cause the tiles to break as soon as they were placed in service.

A thorough knowledge of these bricks and of your own particular problem is necessary to intelligently select the type of bricks that will prove the most economical in your installation. In selecting the proper refractories for your furnace it is well to keep in mind these destructive results:

Abrasion, slagging, spalling, deformation.

The principal causes of these results are:

Chemical—Carbon dioxide, ferrous oxide, sulphur.

Mechanical—Impingement of flame, too rapid heating or cooling.

Thermal—Too rapid a heat transfer through the brick, caused by too thin a wall; too slow a heat transfer, caused by overinsulation.

Structural—Confined expansion, excessive loads.

Temperature in itself, without other destructive forces, seldom if ever causes furnace wall failures.

As mentioned before, first quality brick fuses at a temperature of about 3300 degrees, while second quality brick fuses at about 2900 degrees.

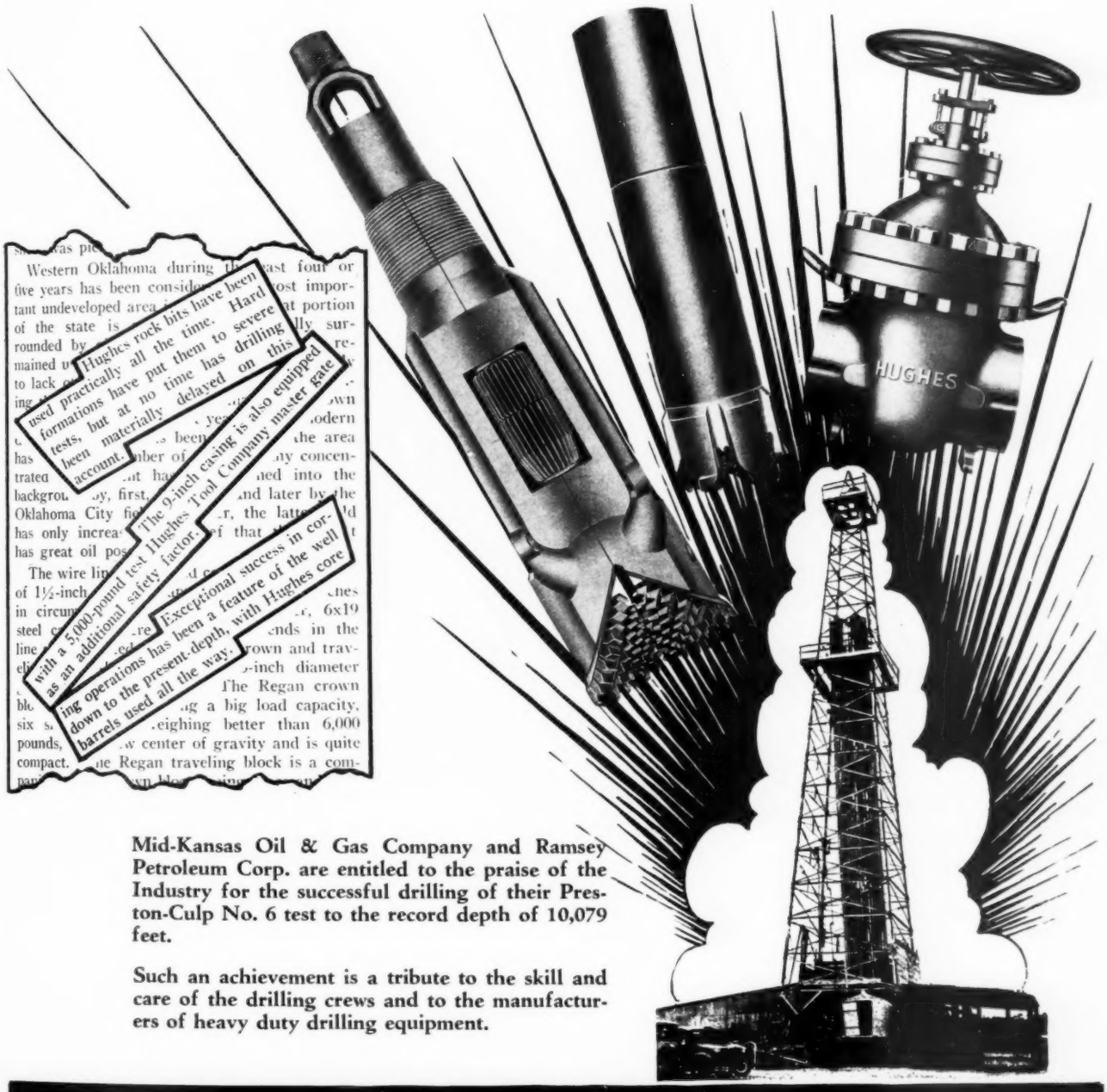
Repeated tests have shown that boiler well temperatures, regardless of whether they are fired by oil, gas, powdered fuel or by stokers, seldom reach 2800 degrees except where the heat liberation per cubic foot of area is excessive, as when the gases are confined within a small area.

All of the principal manufacturers maintain experimental laboratories to experiment with their clay. In the past six years there have been as many developments made in improving the refractories as there have been in the manufacture of gasoline, although the crude materials have been the same.

Unfortunately, the manufacturers' developments have been confined to the laboratory. The responsibility for the successful use of their materials has, until the advent of furnace mason contractors, been left entirely to the plant mason.

Contractors specializing in furnace masonry are rapidly developing and building walls that reduce to a minimum the structural causes of failure.

—again prove their record breaking Performance Qualities on the Preston-Culp No. 6—the Deepest hole in the United States————————10,079 feet



Western Oklahoma during the past four or five years has been considered one of the most important undeveloped areas in the United States. Hard formations of the state is practically surrounded by proven territory. Hughes rock bits have been used practically all the time. Hard formations have put them to severe tests, but at no time has drilling been materially delayed on this account. The 9-inch casing is also equipped with a 5,000-pound test Hughes Tool Company master gate as an additional safety factor. Exceptional success in corring operations has been a feature of the well down to the present-depth, with Hughes core barrels used all the way.

Mid-Kansas Oil & Gas Company and Ramsey Petroleum Corp. are entitled to the praise of the Industry for the successful drilling of their Preston-Culp No. 6 test to the record depth of 10,079 feet.

Such an achievement is a tribute to the skill and care of the drilling crews and to the manufacturers of heavy duty drilling equipment.

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Oklahoma City, Okla.
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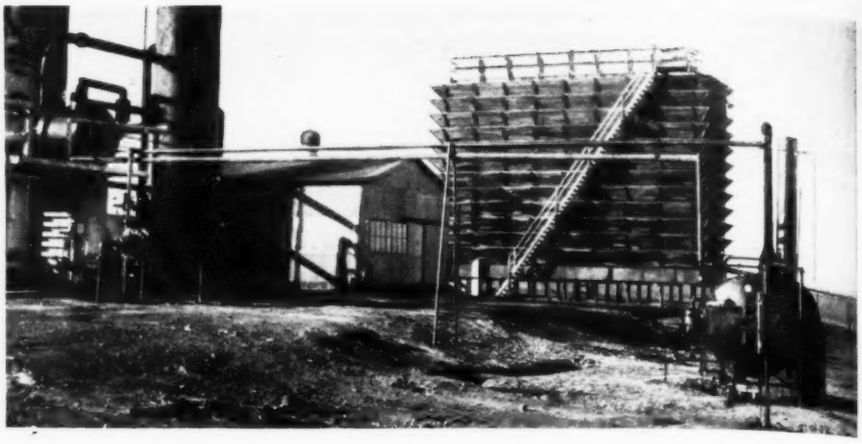
A Method of Cleaning Up Absorption Oil . . . .

EMBY KAYE
and E. I. SELLARS,
Skelly Oil Company



THE outstanding term that the technologist dropped into the lap of the natural gasoline plant designer in 1929 was "molecular weight." While the viscosity of the absorption oil was not a new factor in the design of certain types of equipment, particularly exchangers, and was taken into consideration by some equipment manufacturers, the industry as such did not build its plants around an absorption oil of given molecular weights. It was in that year that plant yields were guaranteed by engineering concerns on the basis of certain absorption oils. Absorber, exchanger and still designs were materially influenced by the molecular weight of the oil which was to be used in connection with that equipment. As a result, the initial costs of plants were lowered and operating expenses reduced. Decreased oil circulation required less motivating power for oil and water and less steam.

In the sweet gas field the improvement was indeed a step forward. In sour gas areas—and most of the fields in this period have been sour gas areas—the reduced oil circulation and distillation facilities proved for a considerable time of questionable value. In fact, it cost operators many a dollar until the exact nature of the trouble was discovered and a suitable remedy provided.

In the Panhandle, Seminole and West Texas plants the absorption oil is readily contaminated with crude oil mists, iron sulphide, sulphur and other foreign matter, with the result that the low molecular weight oil becomes highly viscous and its absorption efficiency reduced. In some Panhandle plants the contamination was so rapid that it became necessary either to change the oil or clean the entire system with steam or cleaning solutions, or suffer, in addition to the inefficient absorption, an increasingly high differential in pumping the viscous oil through the system. Cooling efficiency in cooling coils was naturally reduced, and increasing pressures on heat exchangers and preheaters caused breakage of tubes with attendant losses and down time.

After about a year of theorizing, various sorts of methods to "clean up" the absorption oil were resorted to, and some have been competently described. Here follows a description of the method employed at one Skelly Oil Company plant, interesting because of its solution of the vexing problem at a low cost:

In this plant (as in four others) a 5- by 10-foot shell fire and steam still was installed for the purpose of continuously redistilling a part of the oil by by-passing a small portion of the hot denuded oil to the fire still, where it is continuously redistilled, condensed and returned to the lean oil vent tank.

The still is equipped with a liquid level control valve set to admit sufficient oil to maintain a predetermined level in the still. An operating temperature of 450 degrees F. is maintained on the still by a thermostatic controller operating on the fuel gas. Live steam for agitation and to prevent cooking, and to aid distillation, is injected through a perforated pipe lying in a horizontal position lengthwise in the still, with the perforation facing downward so that the steam blast would strike the extreme bottom of the still to prevent solids from collecting to form carbon, which would soon result in blisters on the shell of the still. Of course, the steam makes for the mechanical carrying over of the oil, so that relatively low still temperature may be maintained. At the low operating temperatures there are none of the usual difficulties incident to partial cracking.

The throughput capacity of the still is variable, depending upon the accumulation of heavy residue remaining in the still after operating for a given time, the minimum throughput running from 5,000 to a maximum of 10,000 gallons per day. During the cleaning up of the system for the first time the still was shut down and dumped daily for the first two days' run, and the length of the runs was gradually extended as the oil became practically as free of foreign matter as the original oil.

A daily shut-in test of one hour was made to determine whether or not the still had become full of bottoms, which must be drained off to obtain efficient operation.

On a plant having approximately 32,000 gallons of oil in the system and a circulating rate of 1,000,000 gallons per day it required approximately 60 days' continuous run to clean up the oil, dissolve and clean out the heavy deposits of gum and sludge clinging to the inside of absorbers, heat exchangers, oil coolers and other oil-carrying equipment.

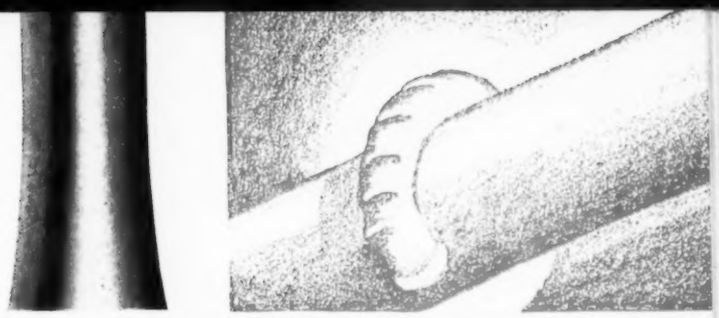
After the oil has been substantially redistilled it is similar in specifications to the fresh oil used as make-up oil. After the system has become clean it requires from three to five days' run each month to keep the system clean and the oil in good condition. Herewith is a set of data which tell the story better than words. The condition of the oil on November 9 was considered excellent and the unit was shut down.

Date	Gravity	I.B.P.	5%	20%	30%	End Pt.	Recovery	Res.
7/ 5/31	29.7	465	475	486	491	615	92.5	7.5%
8/20/31	32.6	444	454	466	473	595	95.0	5.0
9/12/31	33.3	446	452	466	472	583	96.0	4.0
9/20/31	33.4	420	434	447	451	560	96.0	4.0
9/27/31	34.0	418	436	447	451	540	96.5	3.5
10/ 4/31	34.1	400	430	448	453	547	97.0	2.0
10/11/31	34.2	410	435	448	452	546	97.0	2.0
10/18/31	34.5	406	425	437	448	533	98.5	0.5
10/25/31	34.4	399	426	440	445	549	99.0	0.5
11/ 2/31	35.0	388	430	442	446	534	99.0	0.5
11/ 9/31	35.0*	392	432	442	446	532	99.0	0.8

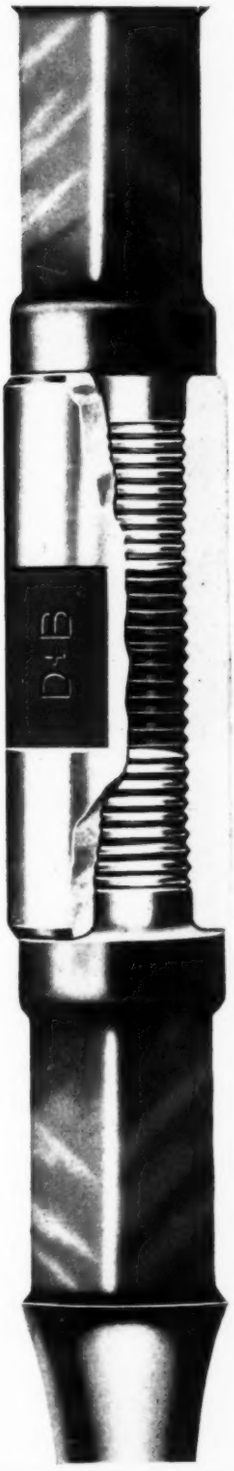
Considering the results in a number of instances, it would appear to the writers that a redistillation unit should, except in the most favorable circumstances, be part and parcel of the design of a natural gasoline plant.

* Owing to the rapid contamination of absorption oil, the oil for this plant was not selected for its low molecular weight. The new oil was 35 degrees A. P. I., although oil since purchased was of 160-170 molecular weight and 38 gravity.

STRENGTH



THAT RESISTS FATIGUE



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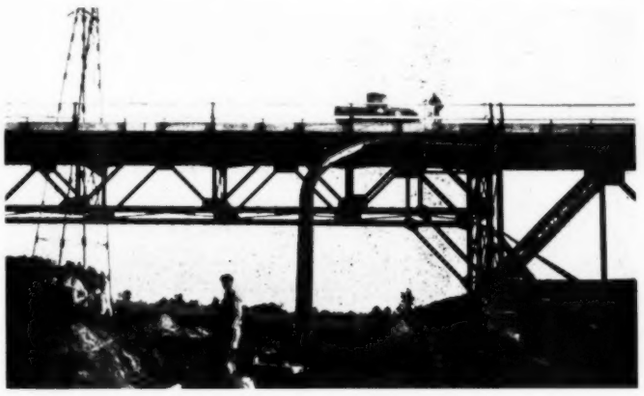
CONTINENTAL

Problems of Laying Large Diameter Line on a Highway Bridge

WHEN the Missouri Valley Pipe Line Co. crossed the Missouri river at Plattsburg, Nebr., on a highway bridge with a single 24-inch line, the chief construction problems were provided by a 90-degree bend downward and a side bend of 45 degrees to the main line.

Construction work was started on the Nebraska side and progressed much in the same fashion as laying under ordinary conditions. In preparation for the work a bridge building contractor built special brackets on the side of the bridge to accommodate the large diameter pipe. A heavy arm was riveted to the main I-beam and was reinforced with an angle iron, making a support identical in shape to an ordinary bracket.



Unique river crossing on Missouri Valley line.

On the end of the bracket a special roller, designed to fit the curve of the pipe, was made. When this work was completed welding was started. Two joints of double bell pipe were welded by the side of the highway. A chill ring was used to make the standard ripple acetylene welds.

As the double length sections were completed they were lined up on the bracket rollers and shoved out with a tractor. Working in a precarious position, the welder on the bridge made an ordinary roll weld as helpers slowly turned the pipe with chain blocks. Chill rings were used in connection with the welding from the bridge and aided in lining up the pipe for the weld.

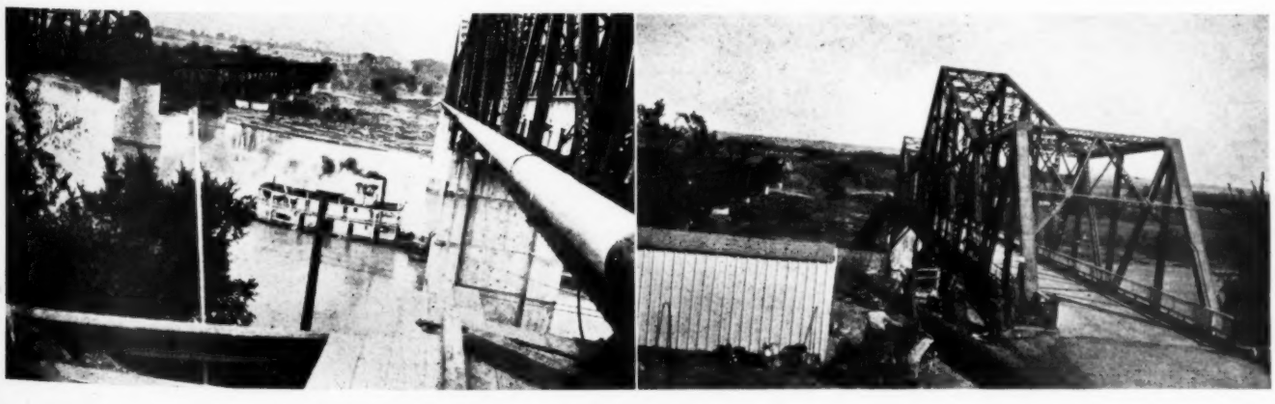
Coming off the bridge on the Iowa side was the most difficult phase of the construction work. For some distance beyond the main bridge a trestle goes over the bottom land and the pipe line left the bridge a short distance away from the river bank. The line makes a 90-degree bend and a 45-degree downward angle in meeting the ground line.

A factory bend was ordered and the straight pipe coming up on a 45-degree angle from the ground line was welded to the bend. A scaffold was built about the point where the bend was to be joined to the pipe on the bridge. When this was in readiness the crews started the tedious task of lining the job up with the pipe on the bridge. When this was accomplished, after numerous attempts, the joint was tack welded and then welded solidly.

To prevent stresses being set up on the joints at the valve connection the valve was reinforced by anchoring it to a concrete block. The line leading to the valve was likewise anchored to concrete blocks and the other end of the line on the Nebraska side was anchored with special clamps.

When the job was completed the line was tested with 500 pounds pressure and held without any drop in pressure for 24 hours. Upon completion it was painted aluminum. Contraction and expansion will be cared for where the line makes its 90-degree bend. The welding job was done under the supervision of E. Glenn, superintendent of welding.

When the line was completed across the bridge it was made secure to the brackets by slipping U-bolts over the pipe and bolting them to the brackets.



Two views of the Missouri River crossing constructed by the Missouri Valley Pipe Line Co.

Covering California Reinforced

By JOHN F.

Placing forms over pipe which has been cleaned and wrapped with mesh reinforcement.

THE eight-inch oil line of the General Pipe Line Company of California, which lies directly on the beach between Ventura and Santa Barbara, has been the source of much annoyance and expense for the past four years. A more severe condition of exposure could hardly be found. The line was exposed continuously to the ravages of salt water, and in spots to alternate wetting and drying. Many types of plastic and semi-plastic coverings failed to protect the pipe from corrosion.

Due to stringent state laws it was imperative that no leaks develop in the line that would permit escaping oil to contaminate the beach and water. This meant constant inspection of the line, with not infrequent repairs to defective spots. The line was formerly in higher ground, but when a sea wall was constructed along certain sections of an adjacent highway, the pipe line was moved forward and down to rest directly on the beach. In these locations the line was inundated about 50 per cent of the time due to tidal action.

It was eventually decided to protect those portions of the line that were on the beach with a rigid reinforced concrete covering applied directly to the pipe. There was a total of approximately 2,400 linear feet of line to be covered.

The construction problems to be met and overcome by the contractor were legion. The tide frequency meant that the line was available for work only a limited time at definite intervals. Excavating and covering a limited section of line had to be done in the same interval of time, as the succeeding tide would fill the excavation and cover the work with the alluvial silt that constituted the beach. The concrete had to be of a quality that would resist the intensity of the exposure. Also, the surface of the concrete had to be protected during the hardening period against the action of the tide. Withal, the cost for the work had to be held within economic reason.

Applying definite knowledge of the durability of concrete in corrosive areas having an intensity comparable with that of the site, indicated that the mixture must be made with five gallons or less water per sack of cement. Also, it must be of such consistency that it would place around the pipe and reinforcement in a dense, compact mass free from holidays and voids. It was obvious that a mortar mixture was not suitable to the work when consideration was given to the ultimate conditions of exposure. Mortar is a mixture of cement and sand, and such a mixture would require an excessive amount of water to produce a material having a definite degree of workability or placeability. Concrete is a mixture of cement, sand and coarse aggregate. When particles of aggregate larger than found in sand are used with the same quantity of cement, the resulting mixture can be made more workable and placeable with less mixing water. Since the total amount of water entering the mix could not exceed five gallons for each sack of cement, it was apparent that concrete and not mortar must be used. There was an economic advantage, also, in using concrete, for when coarse aggregate is incorporated in the mix a large volume of the resultant mass is occupied by these particles, which are the least costly of the ingredients.

The concrete, when made with less than five gallons of water per sack of cement, was not workable in the ordinary meaning of the word, and especially when it was to be placed in such a thin layer around the pipe. The finished concrete covering was to be one and one-eighth inches thick. To place the concrete in this consistency, it was necessary to mechanically vibrate the forms. An electrically operated, high-frequency vibrator with a special carriage to fit the

General location of the line. Except where prevented by boulders, the tide has covered the concrete-protected line with the alluvial silt of the beach.

[1] Assistant Manager, Structural and Technical Bureau, Portland Cement Association.

An 8-Inch Line With Concrete

HOUGH, C. E.[1]

Suspending covered pipe to remove cradle blocks and forms from concrete cast 18 hours previous.

forms was used. The vibrator, applied directly to the forms and operated as the mixture was inserted, settled the concrete into a compact, dense mass of uniform thickness around the pipe.

The line was turned over to the contractor in a clean condition, with all traces of previous coatings and rust scale removed. As the pipe had to be uncovered after each tide, the contractor would open up a length of trench equivalent to the length of pipe that could be formed and covered with concrete in the few hours between tides. The pipe was then brushed clean and the reinforcing mesh put in place. The reinforcement was No. 12 gauge electrically welded mesh, four inches by eight inches, with the four-inch spacing placed circumferentially around the pipe. The wire was specially crimped so as to be held a uniform distance of a half-inch off the pipe.

The forms were made of galvanized sheet metal, bent to the shape of the pipe and divided into halves, with a longitudinal opening left at the top to receive the concrete. They were reinforced with angle iron strips. The half sections were bolted together on the underside of the pipe, and the forms were held a uniform distance off the pipe by special removable spacers. The spacers were so designed that they could be removed as soon as the concrete had been placed, but before the vibration was completed. The continued vibration would cause the concrete to compact into the space formerly occupied by the spacers, thus requiring no patching or filling of holes after the concrete had hardened. Forms were placed on the entire length of pipe to be covered during one-time interval, thus insuring a continuous coating of concrete with no joints to be filled at a later time.

As soon as the forms were in place correctly, the vibrator was placed on the top. The vibrator was equipped with wide flanged wheels to facilitate moving along the forms. A chain sling on the vibrator passed under the forms. This was attached to a quick acting screw arrangement that permitted rapid and rigid clamping of the vibrator to the forms.

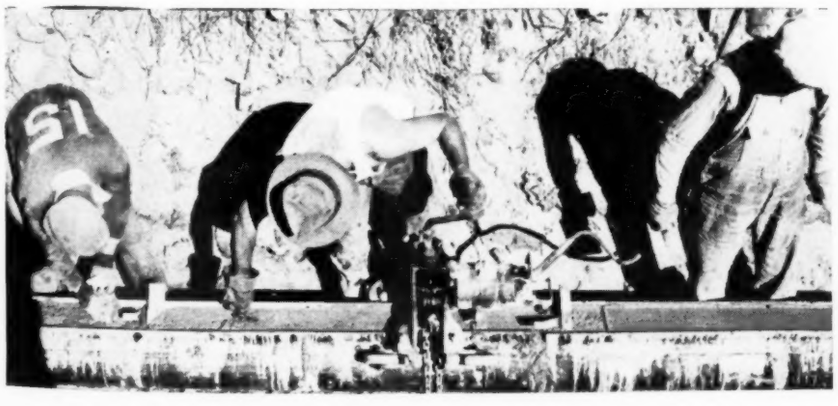
Concrete was then placed in the opening of the forms and the vibrator started. In spite of the unworkable appearance of the mixture, it compacted readily into place under the vibratory action.

The concrete mixture was approximately 1 part Portland cement, 1.6 parts of sand, and 2.5 parts of crushed river gravel by volume measurement. The coarse aggregate was specially screened and recombined to consist of particles varying from ¼ to ⅜-inch. The water content of the aggregate was determined carefully so that not more than 4¾ to 5 gallons of water per sack of cement was incorporated in the mix. An ordinary one-bag batch mixer was used, all concrete being mixed for not less than two minutes.

The forms were left in place for 18 hours and the tide permitted to rise over the covered pipe. The forms were overfilled with concrete, which gave a protective covering of double thickness where the tidal water came in contact with the green concrete.

In spite of the unusual difficulties encountered on this job, excellent time was made. With a crew of only a dozen men, 200 feet of line was formed and covered with concrete each 90 minutes of available working time between tides.

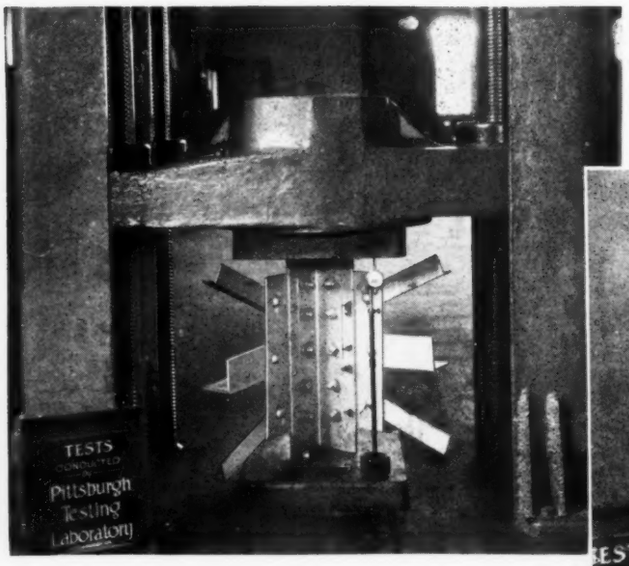
The work was done by the General Contractors, Inc., under the personal direction of E. R. McCracken, who specialize in vibrated concrete coverings for pipe lines. The vibrator used was manufactured by the Electric Tamper & Equipment Co.



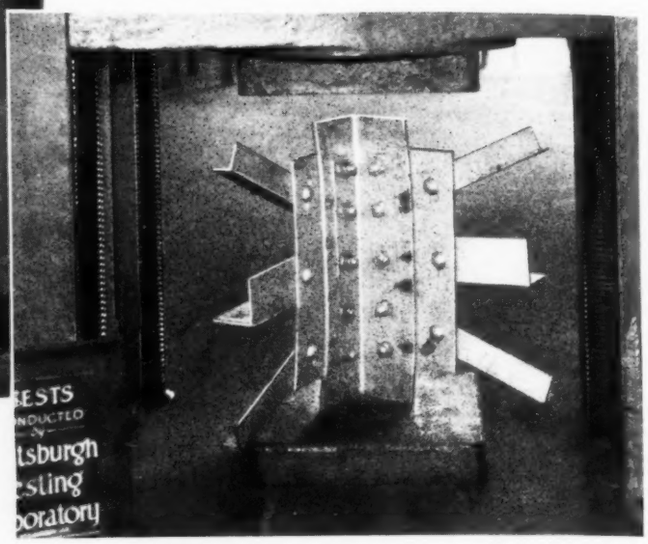
The vibrator in action.

Let this Test guide

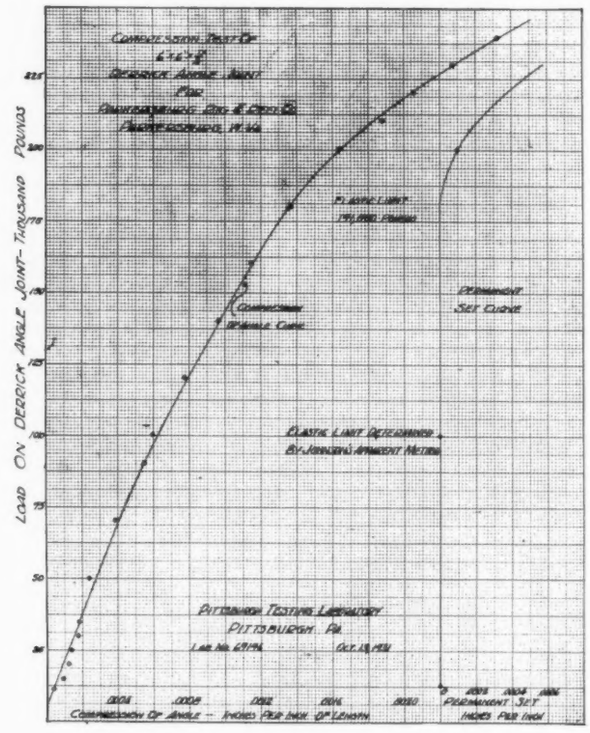
In Buying



Illustrating Pittsburgh Testing Laboratory Compression Machine with Angle Joint of a Parkersburg Derrick set up, ready for the test.



View of the Derrick Angle Joint after it had withstood an ultimate load of 312,650 pounds. The compressive force was continued beyond this point so as to observe the effects of such an unusual load.



The curve shows an elastic limit of 191,000 pounds. The column load rating of a 6-inch by 6-inch by ½-inch leg section (A.P.I. formula) is 80,759 pounds. The difference indicates the margin of safety in the leg joint over the rated capacity of the derrick.

THE PARKERSBURG RIG AND REEL COMPANY

You » Derricks

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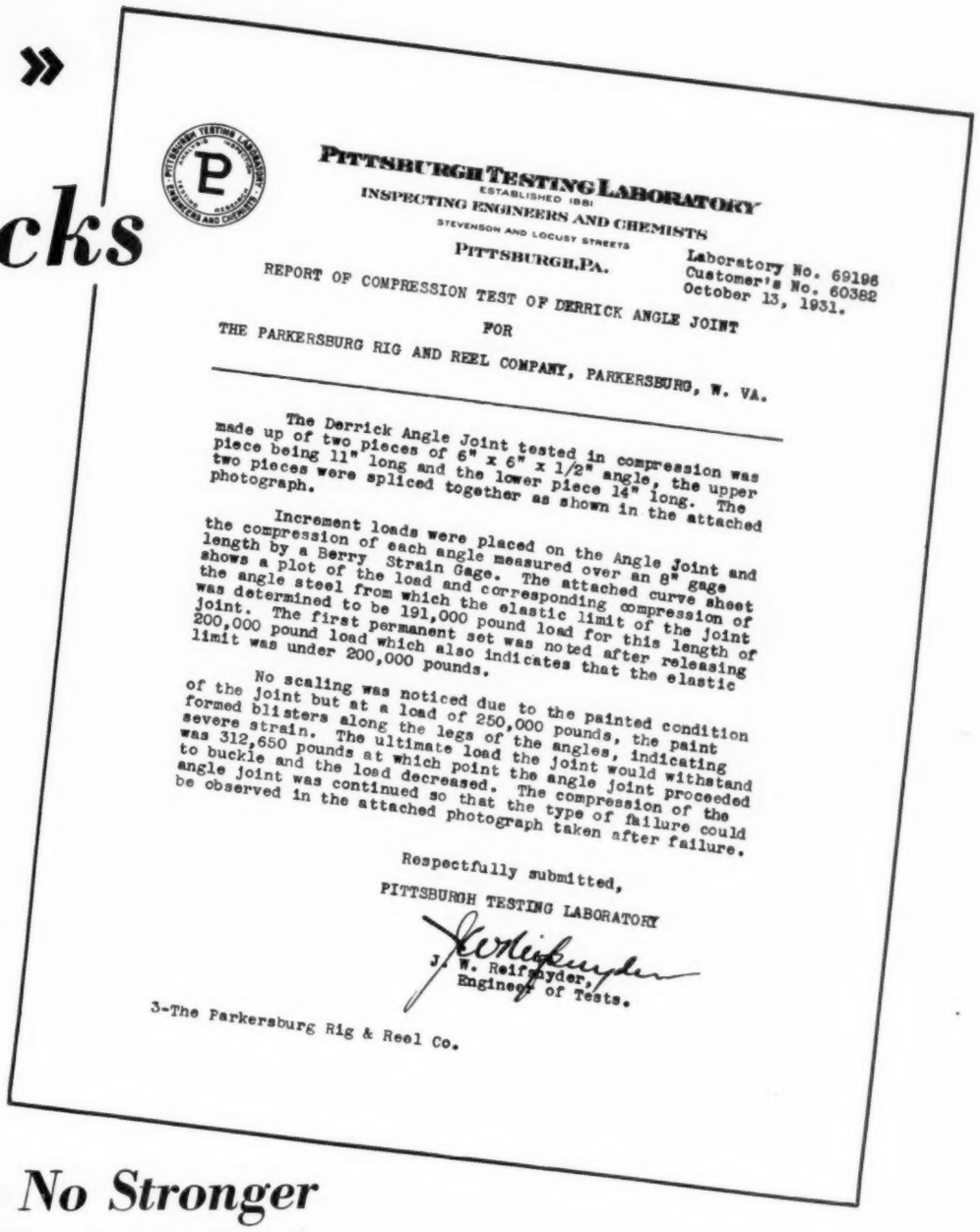

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STEVENSON AND LOCUST STREETS
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Customer's No. 60382
October 13, 1931.

REPORT OF COMPRESSION TEST OF DERRICK ANGLE JOINT

FOR

THE PARKERSBURG RIG AND REEL COMPANY, PARKERSBURG, W. VA.

The Derrick Angle Joint tested in compression was made up of two pieces of 6" x 6" x 1/2" angle, the upper piece being 11" long and the lower piece 14" long. The two pieces were spliced together as shown in the attached photograph.

Increment loads were placed on the Angle Joint and the compression of each angle measured over an 8" gage length by a Berry Strain Gage. The attached curve sheet shows a plot of the load and corresponding compression of the angle steel from which the elastic limit of the joint was determined to be 191,000 pound load for this length of joint. The first permanent set was noted after releasing 200,000 pound load which also indicates that the elastic limit was under 200,000 pounds.

No scaling was noticed due to the painted condition of the joint but at a load of 250,000 pounds, the paint formed blisters along the legs of the angles, indicating severe strain. The ultimate load the joint would withstand was 312,650 pounds at which point the angle joint proceeded to buckle and the load decreased. The compression of the angle joint was continued so that the type of failure could be observed in the attached photograph taken after failure.

Respectfully submitted,

PITTSBURGH TESTING LABORATORY

J. W. Reifsnyder,
Engineer of Tests.

3-The Parkersburg Rig & Reel Co.

Photographic reproduction of Pittsburgh Testing Laboratory Report of Compression Test of Parkersburg Derrick Angle Joint.

A Chain Is No Stronger Than Its Weakest Link--
A Derrick Is No Stronger Than Its Leg Joints

HERE we present conclusive proof that the leg joints in Parkersburg Heavy Duty Drilling Derricks are stronger than the legs on which the rated capacities are based, thus offering an adequate factor of safety under the most severe operating conditions.

Field tests have proved Parkersburg Derricks to be of sound design. This test offers further proof of their strength and safety.

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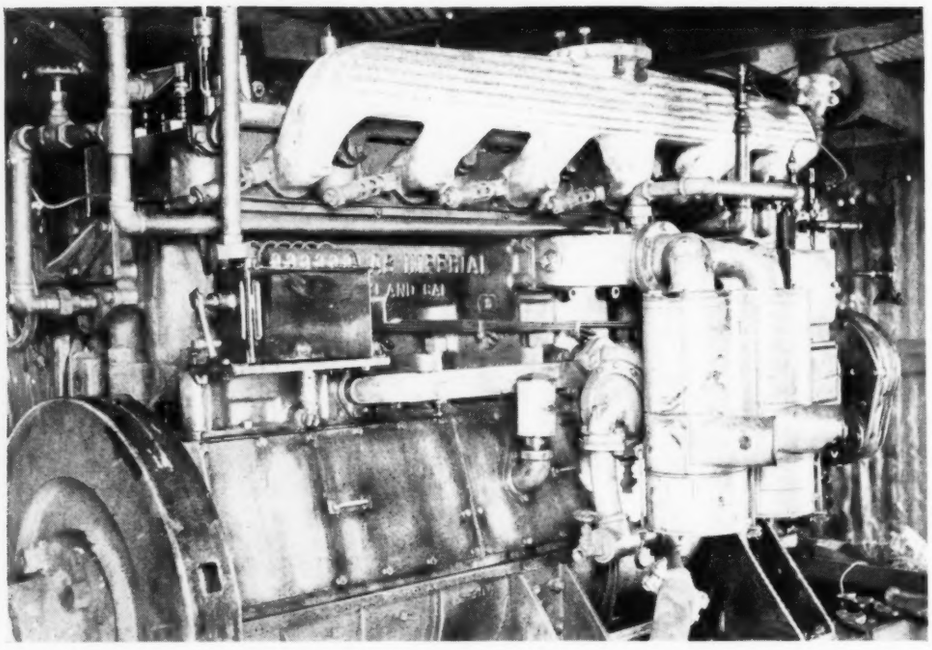
Diesel Units Drill Several McPherson Tests



Close-up picture of one of the Diesel Drilling Engines.

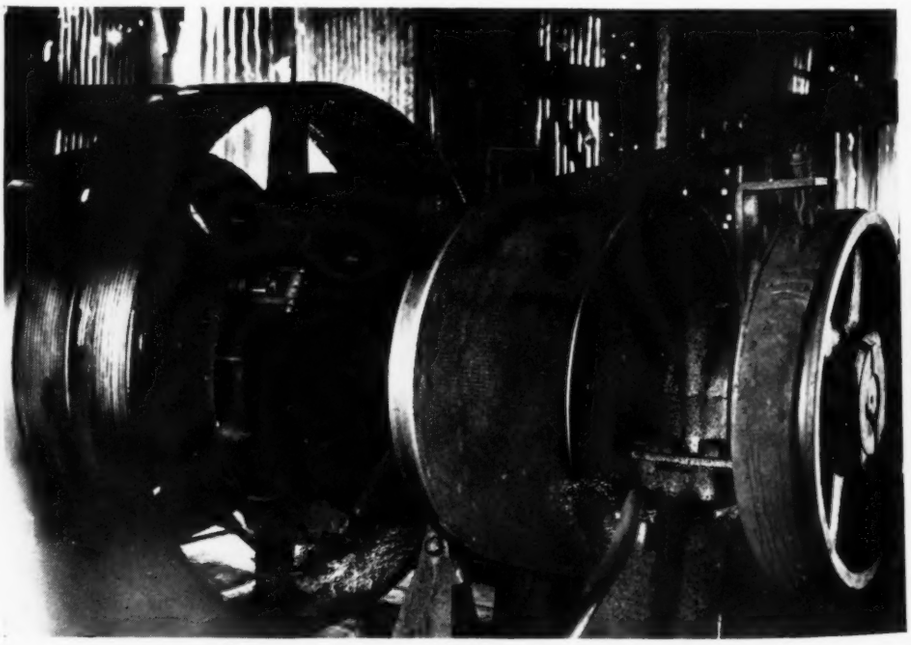
SEVERAL wells in the Ritz-Decker field, near McPherson, Kansas, have been drilled, using Diesel engines as prime movers. Drilling records made with this type power have naturally been of much interest to drilling contractors and operating companies as this has been the first chance to study these units closely in Kansas operations. Two contractors, Henry Rosenthal and Roy Patton, are using Diesel engines and have drilled several wells with each unit.

Drilling footage has been practically the same as on other type prime movers, with little shutdown time. The north end of the district is mostly a gas producing area while the southern portion yields prolific oil production. Gas wells are completed in the chat horizon at 2,900 feet in about 35 days. An additional 10 days or slightly more are usually required to reach the Viola lime at 3,400 feet, where oil production is encountered. Fuel costs have averaged approximately $3.00 per 24 hours.

Both Diesel units in use are six cylinder engines, each with a 200 h.p. rating, and are operating standard tool rigs. They are the latest model drilling Diesels, being entirely enclosed and dust proof. Aluminum covers that enclose the head mechanism, inspection plates, and the crank case cover, permit quick and easy removal for the inspection and adjustment of all working parts. The engines are light in weight, operate at high speed, occupy small space, and are lubricated through a force-feed pressure system.

The drive shaft of the engine is coupled to a pulley shaft with a flexible coupling. A belt from the pulley to a countershaft, and another to the band wheel transmit the power. The use of a countershaft has been instrumental in reducing trouble with belting, and in obtaining the desired ratio of speed. The flexible coupling, placed between the engine and pulley, eliminates strains both from starting torque and alignment. The engine and pulley unit are bolted to the same steel I-beam skid, aiding portability and reducing vibration.

This field continues to be the most active spot in the state and its present proven boundaries indicate that it may become the largest Kansas pool in area. Because of the anticipated drilling campaign in this area, these Diesel units will likely do a great deal more work in this locality, permitting the gathering of further information on their performance.



View of the countershaft used with Diesel Drilling Engines on standard rigs.

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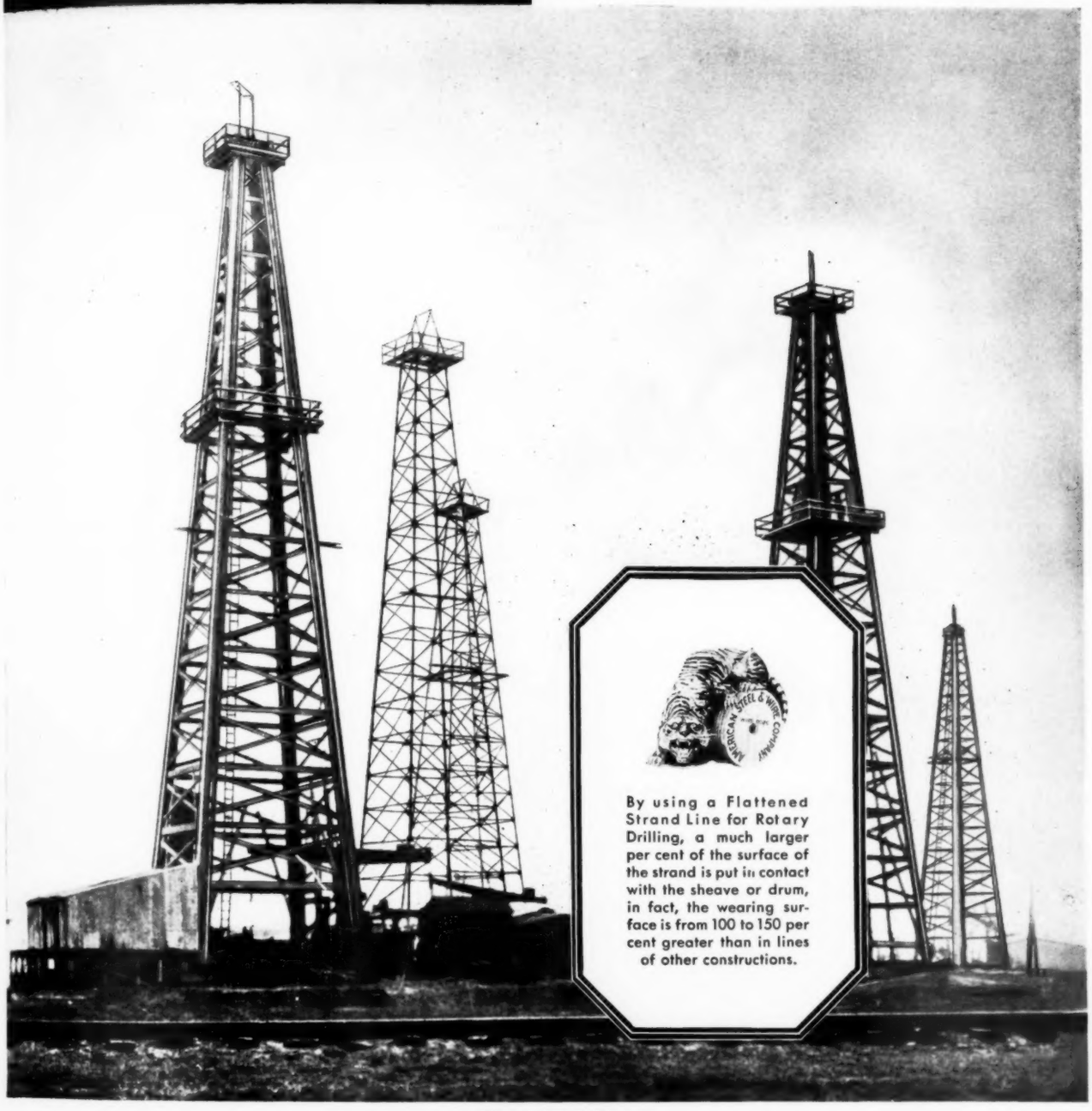
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Factors Involved *in the* Lubrication

THE economical operation of Diesel engines is dependent on correct lubrication. This demands that a suitable oil film be formed and maintained between the moving parts of the machines to assure minimizing wear and tear of the unit parts. Wrist pins, crank pins, main bearings and crosshead guides of Diesel engines all require their share of attention. With the possible exception of the wrist pins which are contained in an enclosed position and may be subjected to considerable unradiated heat, the above parts will, in general, involve no difficult lubricating problems. Pressures are usually high, clearances low and operating speeds frequently high; yet the circulating force feed oiling system, the mechanical lubricator, or the principles of splash lubrication (in the enclosed crankcase engine) are all readily adaptable.

On large engines the first is preferred by many authorities. In effect it is probably the most dependable system in that it furnishes a continuous stream of oil to all the bearing parts in question, assures an adequate oil wedge, assists materially in cooling and is capable of being put in series with a filtration or purification system which will insure the delivery of practically pure oil, thus eliminating the possibility of clogged oil ways. Furthermore, the oil feed to each part, in certain cases, can be independently controlled.

One oil is generally used for all bearings of a Diesel engine and should be selected to suit those bearings subjected to severest operating conditions. With the mechanical lubricator it is possible to make it serve both cylinder and bearing lubrication, by keeping the requisite lubricants in separate compartments, although where but one grade of oil is required this would not be necessary. With more than one oil there is, however, always a possibility of these being mixed up and for this reason many authorities insist that separate lubricators be used under such conditions.

A variation exists in the pressures used on lubricating systems. While with some engines the pressure will not exceed five pounds per square inch, in others it is carried as high as twenty pounds per square inch. This pressure will be influenced by bearing clearances, and a noticeable drop in pressure may occur with a new engine as the wearing in of the bearings progresses.

Mechanical Force Feed Systems

Force feed lubrication is perhaps the most popular means of delivering oil to the cylinders of a Diesel engine. Force feed lubrication as used for cylinders and air compressors can be regarded as high pressure lubrication, where pressure as high as 1,000 pounds per square inch is employed, as compared with the relatively low pressure systems used for the miscellaneous bearings of certain types of engines.

With force feed lubrication each lubricator consists of several individual adjustable pump plungers receiving their oil supply from a reservoir in the body. They feed accurately measured quantities of oil to suit the parts being lubricated. Sometimes provision is made for lubricating the piston pin by the same means, although the piston pin may be lubricated by the bearing circulation system. Several leads are usually employed to conduct the oil to the cylinder walls, the number depending on the size of the cylinders.

Where force feed lubrication is used on main and other bearings, they are flooded with a continuous and adequate supply of oil which assures the formation and maintenance of a complete lubricating film at all times. A mechanical force feed lubricator, being practically always driven by the machine which it serves, only functions when the latter is in operation and at a proportional speed. The pumping capacity and rate of oil feed is therefore variable. By suitable adjustment of the lubricator it can be very accurately regulated to meet whatever lubricating requirements the bearings may involve. On some of the smaller Diesel engines the mechanical lubrication system is employed for the bearings as well as for the cylinders. Oil so fed to the bearings is usually recovered from the engine crankcase, filtered, and cooled, and returned to the mechanical lubricator for reuse.

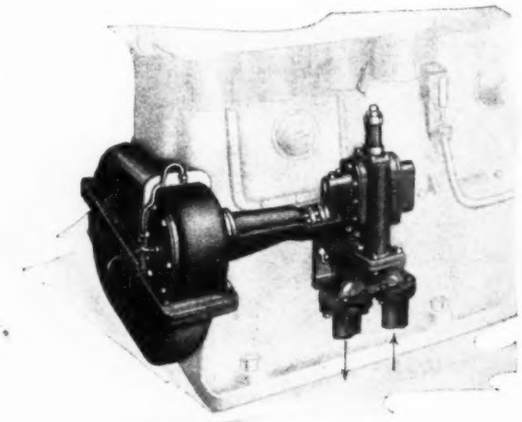
Pressure Circulation Systems

The continuous circulation of oil through bearings affords a very practical and economical way of automatically lubricating such parts with a minimum of labor and attention. As a rule, a considerably greater volume of oil will be involved in a circulating system than in a mechanical force feed lubricator.

A typical circulating system will involve a suitable oil reservoir in the base of the machine, a pump for transmission of oil either to an overhead auxiliary tank, or directly to the bearings to be served, and the necessary distributing pipes to each of the latter. Each line should be fitted with a sight feed device and adequate means for individual adjustment of oil flow. Means will also be necessary for drainage or transmission of used oil back to the base reservoir or sump tank.

Such a system is advantageous in that it provides for sufficient settling of the oil to insure precipitation of the greater part of any foreign matter that may have been picked up by the oil in passage through the bearings. Furthermore, the latter are practically flood lubricated, which not only means that they will normally be washed free from accumulations of foreign matter, but also cooled to a certain extent.

It is also perfectly practicable to provide for adequate pressure either by gravity or pumping, to maintain a sufficient pressure on the oil films which partly serve to resist



AKTIEBOLAGET ATLAS DIESEL
Showing a gear wheel pump for lubrication and cooling of Atlas Polar Diesel engines. Oil is delivered by the gear wheel pump in this forced lubrication system to the main bearings, top and bottom end bearings, while the cylinders are lubricated by means of a special force feed lubricator.

# of Diesel Engine Bearings

By ARTHUR M. TODE, M. E.

such operating or reaction pressures as may be involved on certain of the bearings. With some installations the pressure gauges of the lubricating system are equipped with both high and low pressure alarms to call the engineer's attention to pressure changes beyond permissible limits.

This is the usual system employed for lubricating the various bearings of Diesel engines. A circulating oil pump driven off the engine delivers the oil, under pressure to the main bearings and through ducts to the crank pins, piston pins and other parts requiring lubrication. After passing through the bearings the oil drops back into the crankcase from which it is pumped to a separator or other purifying device from which the oil is again recirculated through the system. In order to keep the oil at or near a constant, moderate temperature, water cooling coils are sometimes employed to dissipate the heat acquired during circulation through the system.

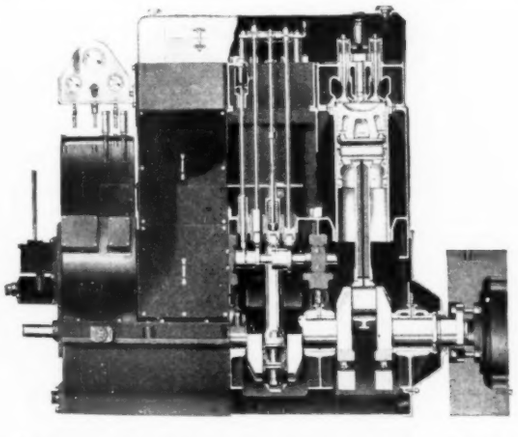
Splash Oiling System

This system is used on comparatively small cylinder, high speed engines where the circulating oil for the bearings also furnishes the lubrication for the cylinders. In this type of system the cylinder lubrication depends primarily upon the oil throw or splash from the crankcase. During each stroke an oil film is formed on the lower part of the piston and cylinder wall which is replenished on the successive upward stroke by the piston rings as they pass over. The oil drains by gravity to a reservoir within the crankcase.

Efficient lubrication results in these engines because of the liberal amount of oil thrown from the moving parts on its escape from the bearings. For such service a lower viscosity, minimum carbon oil is recommended with the characteristics of a bearing oil, in the neighborhood of 300 to 500 seconds Saybolt at 100 degrees Fahr.

Ring and Chain Oilers

The lubrication of main bearings is sometimes accomplished by the use of ring or chain oilers. A continual delivery of oil is assured to the wearing surfaces by means of a ring or chain suspended from the shaft, and free to rotate therewith, the lower part dipping in a bath of oil which is carried in a suitable reservoir in the lower part of the bearing shell.



Transverse section of a direct reversing Superior Engine Company Diesel engine where the pressure lubricating system supplies all the bearings with oil under approximately fifteen pounds pressure, which insures ample lubrication. All working parts, including lubricating oil pumps, are completely inclosed, preventing loss of oil. Lubricating oil is recycled through a filter and cooler, insuring minimum consumption.

In order to insure effective lubrication by such mediums the reservoir must be of adequate capacity to give the oil ample opportunity to rest, thereby making possible not only the settling out of sediment and other foreign matter, but also cooling to the requisite degree. As a rule, the only way in which the oil in such a system is kept at the proper temperature is by radiation of heat from the interior surfaces of the reservoir or lower part of the bearing.

Oil which is carried to the top of a ring or chain oiled bearing must be returned to the reservoir as rapidly as it is delivered by the ring in order to avoid accumulation of oil in the upper part of the housing to be forced, ultimately, out from the ends of the bearings. The same condition may arise if the oil is carried too high in the well, or if the ring rotates at too high a speed. This will cause a splashing and churning of the oil.

On some engines lubrication of the main bearings, particularly those on the outboard side, is accomplished by the use of oil rings and by a subsequent distribution of this oil to the journals upon which the rings ride. The oil is collected from around the main bearings or else from a separate gravity feed supply in the centrifugal banjo coils or rings, attached to the crank webs. By means of centrifugal force a positive flow of oil is made to the crank journals through drilled holes.

A system of gravity circulation of oil is found on small sized engines. Although the oil circulation is continuous and automatic, the oil is not supplied under pump pressure in this type of system.

Oil Throw System

In lubricating systems where oil throw is used, the oil escapes from the crank bearing and is subsequently thrown to the cylinder walls of single-acting engines in sufficient quantities to assure liberal lubrication. The employment of this non-forced lubrication necessitates certain special features in connection with the crankshaft. Rings are turned on the latter, at each end of the journal, to throw the squeezed out oil into suitable catcher grooves in the bearing brasses, whereby it is returned to the oil well instead of being thrown off by the crank webs.

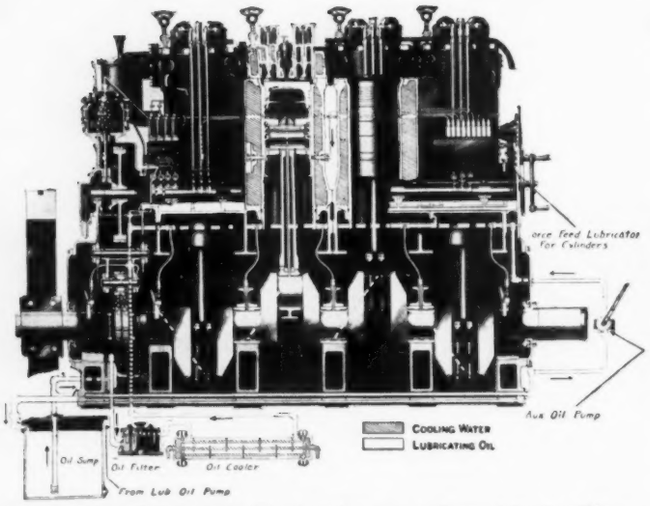
Amount of Lubrication Required

The quantity of oil circulated through a bearing lubricating system varies widely in different engines, being dependent on the size and speed of the units as well as the design of lubricating system installation. The chief requirement is that the amount circulated shall be greatly in excess of what is actually required for lubrication, so that the large amount of oil flowing through the bearings may serve as a cooling medium in addition to maintaining a film between the bearing surfaces.

In the matter of overheated bearings there is little criteria —no two people will agree upon the degrees of warm, hot and too hot. An engine operator can only trust to his own experience.

Oil Wedge Principle

Where shafts or journals, such as the main and other



Sectional view of Type RHA Diesel engine as manufactured by the Chicago Pneumatic Tool Company, showing cooling and lubrication systems. Note path of used and of cleaned oil through sump tank, oil filter and oil cooler.

bearings are involved, effective lubrication can be most dependably attained by providing for passage of oil from the low pressure to the high pressure area. As a general rule this will mean from the upper to the lower part of the bearing.

For this reason oil holes are usually located in the top part or cap of the average bearing, when lubrication is to be maintained from an external source. In addition, by suitable grooving of the top part or low pressure area of such bearings, where practicable, delivery of adequate oil to the point of entry of the high pressure area can be more nearly obtained.

When a bearing which is at rest, starts to revolve, the lubricating oil adhering to the journal is drawn in the form of a wedge into the pressure area. If the velocity of the bearing is very low, and especially if the oil be viscous, it is very possible that no oil film will be formed. It is claimed, however, that with a velocity as low as ten feet per minute, oil is drawn into the bearing of the journal and forms a wedge. This wedge of oil forces the shaft over and raises it in the horizontal direction, at the same time completely separating it from the bearing. As the velocity increases the thickness of the oil film becomes more uniform and the center of the shaft approaches more closely to the center of the bearing. If the load be now increased, as the speed is kept constant, the journal tends to approach a point on the bearing about 40 degrees from the vertical. If a further increase in load be applied, the oil film will be ruptured with resultant friction, hot bearings, wear and possible breakdown of the unit.

Oxidizing Influences in Lubrication

Oxidation occurs on all types of engines and is due to the gradual absorption of oxygen by the oil. It becomes evident by the presence of a brownish sludge, if the oil is left undisturbed for some time. The lubricating oil in a pressure circulation system enters the bearings and assists in the formation of a wedge-shaped oil film. Upon its escape from the ends of the bearings it is thrown violently about in the crankcase and broken up into fine spray due to the action of the revolving crankshaft. There is thus a very large surface of the oil in an atomized state exposed to the attack of oxygen.

This fine oil spray coming in contact with the hot air in the crankcase is subjected to an oxidizing effect, especially in the presence of water and other impurities. This oxidation, accelerated by the constant churning effect, promotes emulsion and has a very detrimental effect on the lubricating oil. Careful selection of the crudes from which the oil is manufactured and equal care and skill in its refining will produce a high grade lubricating oil suitable for this service.

Other Influencing Factors

There are other additional burdens placed upon the oil in a Diesel lubrication system. Impurities which may contaminate the lubricant may be caused by water leakage from the cooling system, or deposits from fuel oil, or dust contained in intake air. These may reach the lubricating oil in the crankcase in the form of cylinder drip.

In engines where lubricating oil is used for cooling the pistons the discharge from the piston head is sometimes led direct to the crank pit, allowing the piston cooling oil to mix with the bearing oil. This oil, in its circulation through the pistons has naturally come in contact with the very hot inner wall of the piston head. The oil must be able to resist to the greatest extent any tendency toward breakdown when exposed to this high temperature. The formation of carbon deposits on the inside of the pistons will retard the transmission of heat from the piston to the circulating oil whereby the setting up of excessive heat stresses may result in cracked pistons.

Results of Oil Breakdown

It can be readily appreciated that the severe service conditions prevailing in a Diesel engine lubricating system will result in breakdown of inferior or unsuitable products. This is usually manifested in the precipitation of gummy deposits, although these are not always easily detected and the oil may still appear to be in fairly good physical condition. These gummy deposits are most dangerous when they lodge within the oil pipes leading to the bearings, or the oil ducts within the crankshaft or the connecting rod. The accumulation of such deposits may not be observed until sudden restriction or stoppage of oil to some bearing or group of bearings may cease entirely, with resultant burned out bearings and possible serious consequences.

Bearing Wear of Diesel Engines

Bearings may be classed generally under two divisions: journal bearings and thrust bearings. Journal bearings are cylindrical and the load is carried at right angles to the axis of the bearing. When the load is carried or applied in a line parallel to the axis, we have what is called a "thrust" bearing. In addition, a further class might be added consisting of those bearings which permit moving parts to slide over them, such as the crosshead guides. These are known as "sliding-contact" bearings.

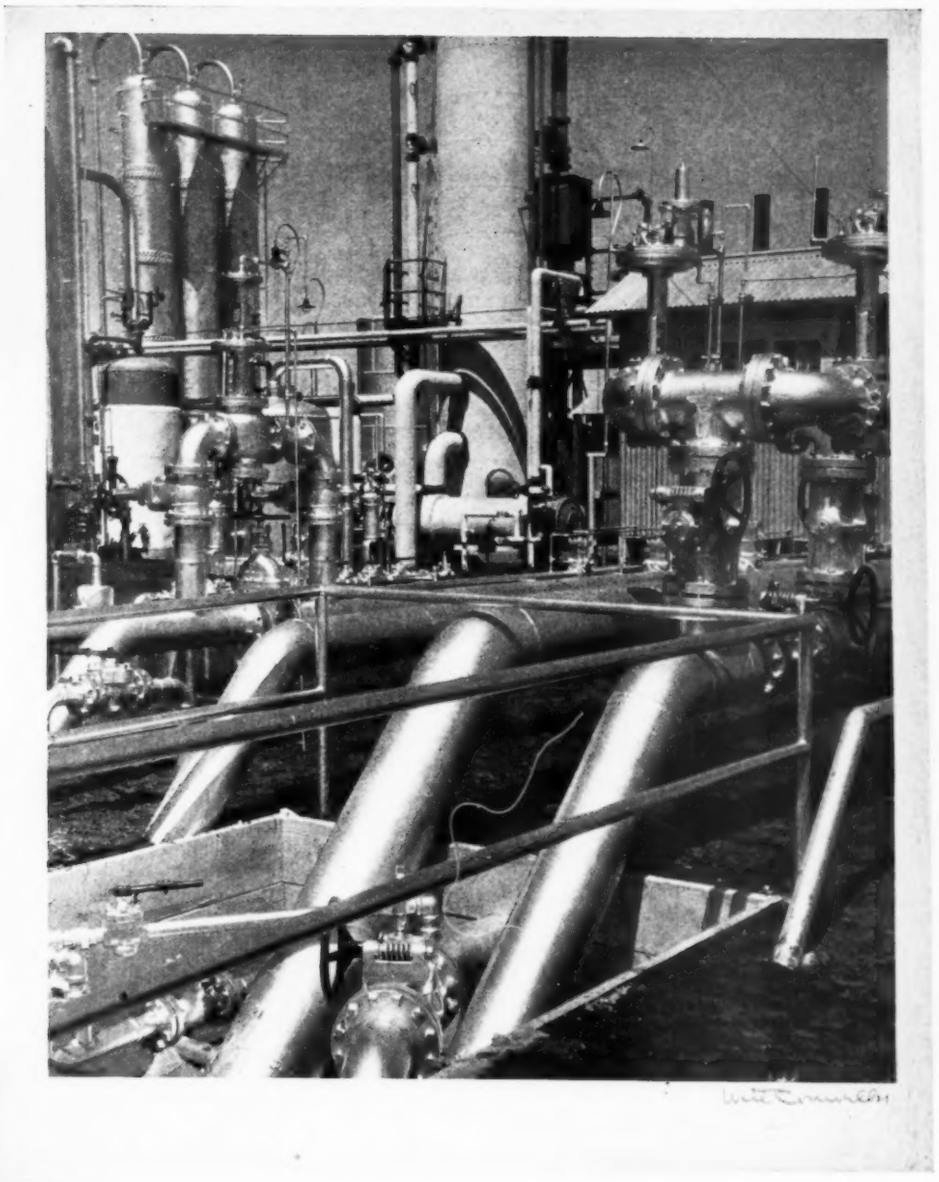
The difficulty presented in supplying proper lubrication to a cylindrical bearing arises from the fact that the lubricant will not flow at right angles to the axis of the journal, nor parallel to the line of surface motion, but has a tendency to flow at various angles from such lines, and always toward the ends.

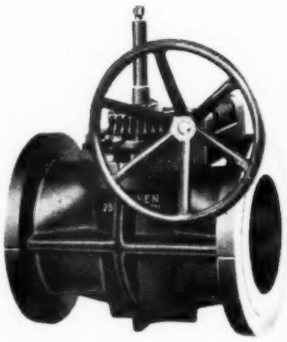
The evil and undesirable consequences of excessive bearing wear may be as serious as those of excessive cylinder wear or even more so. It is impossible for metal surfaces under pressure, such as journals and bearings, to rub one on another even for short periods without generating heat, which will quickly become excessive and eventually destroy the material. Such surfaces must be positively separated by a film of lubricating oil.

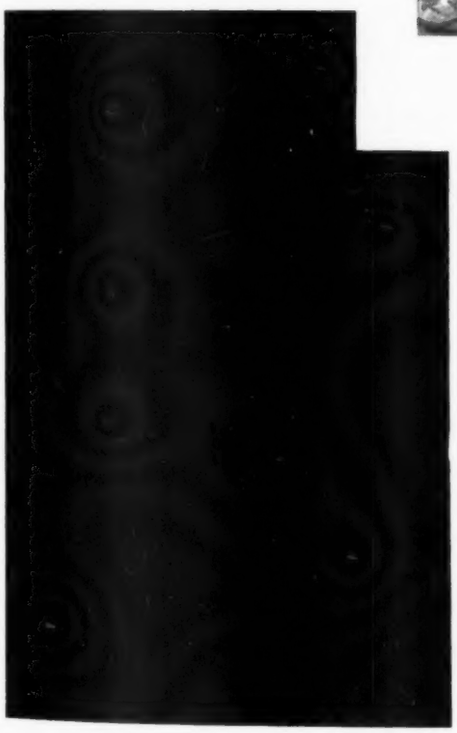
While cylinder wear, in extreme cases, leads to loss in compression and consequent loss in power, excessive main bearing wear in addition to loss in power may also lead to fracture of the crankshaft. Bearing troubles are not always apparent or audible. In a two-cycle, single-acting engine, for instance, where the load on a bearing is always in one direction, that is, downward, quite a bit of wear may exist

THE PERFECT APPLICATION OF A PRINCIPLE

A gasoline plant in California equipped with Nordstroms.







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without any audible signs, while in the four-cycle engine comparatively smaller amounts of wear may be indicated by pounding at the end of the exhaust stroke.

Effect of Oil Body on Various Bearings

The resistance of an oil film to squeezing action is dependent on the body or viscosity of the lubricating oil, the size of the engine bearings, the speed, the unit pressure and the temperature of the oil.

Under conditions of starting, or in the case of slow movement as with piston pin oscillation or crosshead bearings, the formation of an oil wedge and maintenance of an oil film are effected, and there is a tendency of the oil film to be squeezed out of the pressure area. Viscous or heavy oils produce a thick lubricating film and it is for this reason more difficult to squeeze the heavy oils from between bearing surfaces. Such oils are used where the bearing pressures are high, the clearances large or the temperature of operation high. Of course, if too heavy an oil be selected for a certain service the fluid friction and the consequent bearing temperature will become excessive, and the separation from inevitable impurities within an oiling system is made difficult.

It is necessary to use a thin oil where high speed bearings are employed because it gives the minimum of friction, and because the friction generated by the high rubbing speed of the journal would be abnormally increased by the use of a heavy oil. In high speed bearings the bearing pressure is generally light, which permits a thin oil. However, if too light an oil is used, the lubricating film is not sufficiently viscous to keep the metal surfaces apart. This will readily cause rapid wear and result in burned out bearings. As such an oil is readily atomized on escaping from the bearings, the spray thus formed in intimate contact with air promotes oxidation. Excessive lubricating oil consumption may also result from the use of too light an oil according to the engine design, operating conditions and opportunities for oil leakage.

Frictional Resistance in Lubrication

Probably the principal reason why the lubrication efficiency of oil is not given more general attention is because a great proportion of the losses incurred through faulty lubrication are hidden. As long as an oil is not giving any unusual or flagrant trouble it is often assumed that it is efficient, while as a matter of fact, the use of an improper lubricant may be causing a heavy power load factor.

A condition met with in lubrication that does not seem to be fully apparent to the average user of oils is that frequently there are chemical or physical imperfections in the metals of the bearings or journals, or some mechanical defects in the fitting of these parts that are not discernible by the naked eye. Yet tests have clearly indicated that excess friction and correspondingly high temperatures can be, and often are, caused by variations in the smoothness of the bearing or journal surfaces that cannot be easily detected.

All surfaces are more or less rough; even surfaces which are well machined and polished show under the microscope small projections and depressions. It is the interlocking of these minute projections which causes solid friction when two surfaces are pressed together and move relative to one another without lubrication.

The object of all lubrication is that the lubricant should attach itself to the rubbing surfaces, and form a film between them, which under the conditions of speed, pressure and temperature prevailing will not be squeezed out, but will keep the frictional surfaces apart. In perfectly lubricated bearings the rubbing surfaces never actually touch one another and the friction is entirely dependent on the lubrication. The frictional resistance with fluid friction is dependent upon the speed and area of the rubbing surfaces and the viscosity of the lubricant at the working temperature of the oil film, but is independent of the pressure between surfaces, the condition of the rubbing surfaces, and the materials of which they are composed.

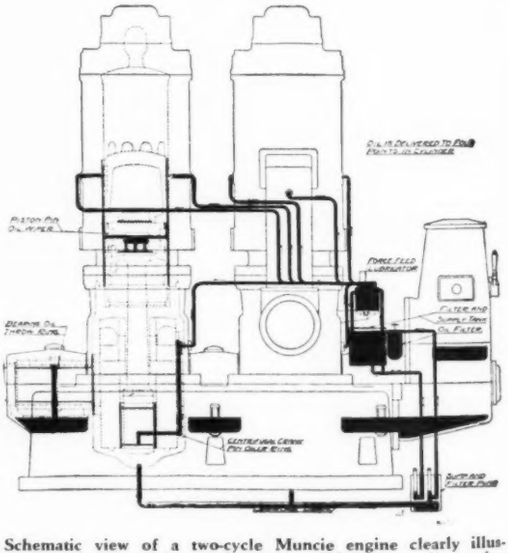
When an engine stands idle for some time the oil films on the various working parts are more or less completely dissipated. The sustained pressure, due to the weight of the parts has caused the oil films to be squeezed out with the development of a certain amount of metallic contact. This results in a considerable starting effort of an engine and the static coefficient of friction approaches that of solid friction. The starting effort will, of course, depend on the conditions and nature of the surfaces in contact and the pressure between them.

Just as the surfaces begin to move the kinetic coefficient of friction comes into play, but as the speed increases and oil film is formed, the kinetic and solid friction decrease until perfect film formation is attained. The high values of the static coefficient easily explain the great effort often required to start an engine from rest; therefore, the introduction of ball or roller bearings, where there is practically no difference between the static and kinetic coefficients would be advantageous.

Miscellaneous Lubricated Parts Require Attention

Inlet and exhaust valves of Diesel engines require oiling but this must be done sparingly. If too much oil is applied to the exhaust valve spindle it will only burn and carbonize, and may quite easily cause a seizure of the valve stem. A usual practice to keep exhaust valve stems free is the periodic application of a small amount of kerosene while the engine is running. Valve rocker arms are usually lubricated by hand, although in some designs from the circulating system.

Camshafts are generally lubricated by feeding off the main circulating system. Owing to the low peripheral speeds and the intermittent loads no difficulty should be encountered. The camshaft is usually gear or chain-driven, and as the lubricant for these drives is necessarily the same as that used for the crank chamber, note of the drive should be made when selecting a suitable crankcase lubricant.



Schematic view of a two-cycle Muncie engine clearly illustrating the methods employed for lubricating all moving parts. A force feed lubricator is mounted upon the engine for the lubrication of the cylinder, piston pin bushing, and crank pin bushing. The main bearings are ring oiled from a bearing oil reservoir just beneath each bearing, while the governor and injection pump mechanisms are flood lubricated from the oil which circulates in these compartments.

1 **Example No. 1**—This drilling operation was surrounded by producing wells, but at the expected depth, that is, approximately 5,000 feet, the producing sand was not found. A survey was made which showed the well from 1,000 feet down to be badly off the vertical and having a maximum angle of 19°. The well was plugged back to less than 800 feet and redrilled. This was extremely expensive, as over 4,000 feet of hole cased with 10" casing was lost and none of the casing salvaged. When the well was started again, a SYFO CLINOGRAPH of the Go-Devil type was used constantly and the well kept within a small degree of vertical. At the expected depth, the sand was found and a good well resulted. This case shows the difference between a dry hole and a producing well, through not checking verticality, including the loss of 4,000 feet of 10" casing.

2 **Example No. 2**—A well drilled in the Texas field was surveyed with a SYFO CLINOGRAPH and the results found were as follows: at 500 feet, straight —at 1,000 feet, straight—at 1325 feet, 5° off vertical—at 2546 feet, 11° off vertical. After 48 hours of reaming, no improvement was noticed so the well was cemented back and redrilled. This resulted in the loss of 1,500 feet of hole and the labor and material consumed in forty eight hours of reaming. The loss more than took away any profit the drilling contractor hoped to make on this well, as contracts in the East Texas field are rather low priced and if a contractor has any loss at all, it more than eats up his anticipated profit.

3 **Example No. 3**—A well known producing company in the Humble field made only a 200 barrel well when surrounded by wells good for from 800 to 1,000 barrels. A SYFO CLINOGRAPH survey was made and the well was found to be about 21° off the vertical at about 4,500 feet. As the well was completed, no attempt was made to straighten it up. The results of these findings, however, caused the owner to adopt SYFO as standard for use in drilling all future wells. It is a question whether it will pay to keep this well open when the time comes to place it on the pumps because of excessive rod wear and difficulties of swabbing due to its wide deviation of direction.

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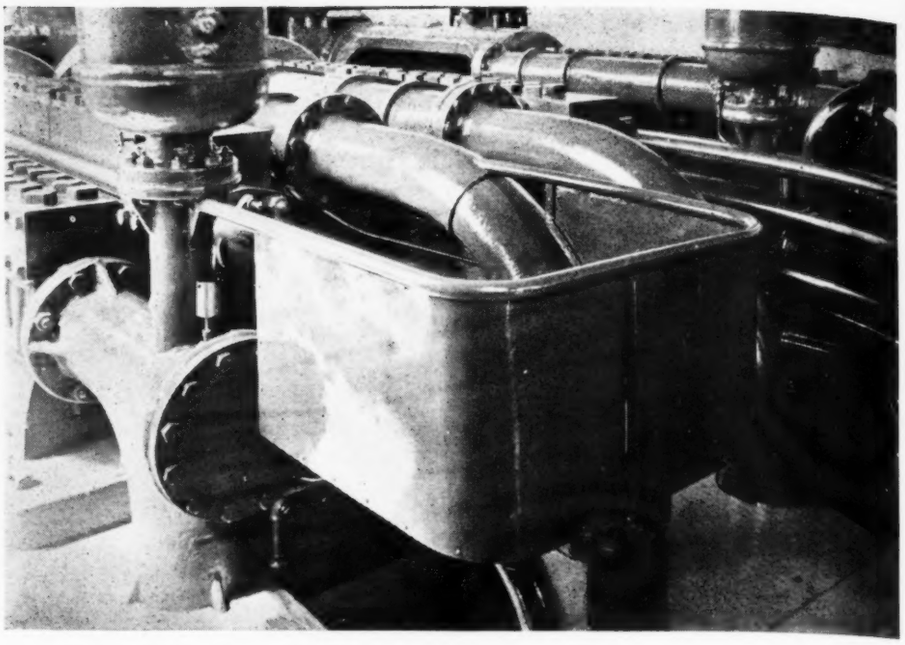


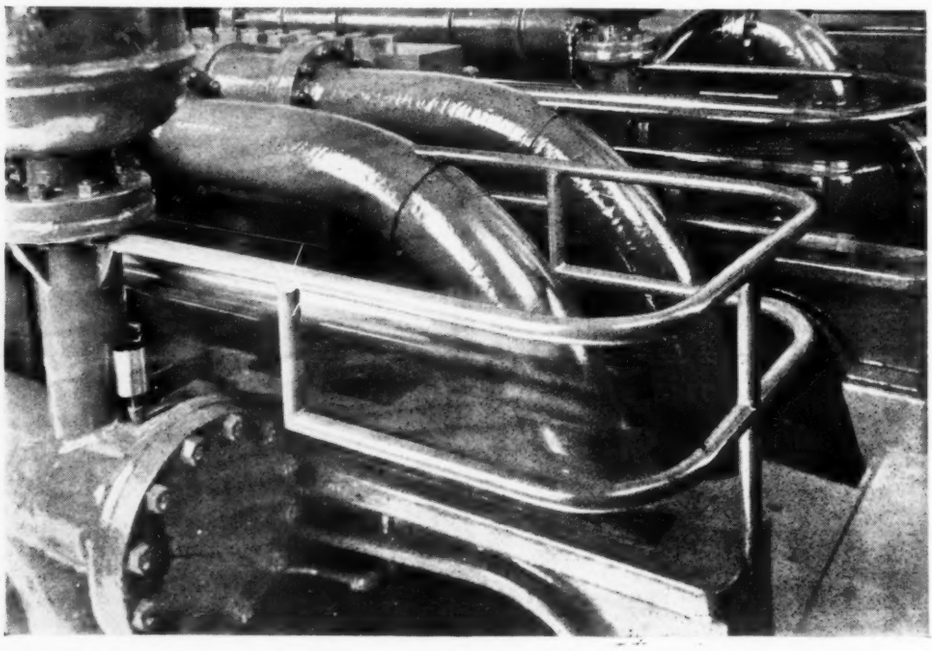
Apron type guard attached to pump.

IN pipe line stations where the reciprocating pumps are on bed plates located below normal ground level, the steps from the door of that side of the building sometimes lead directly to the pump plungers. In such cases there is the possibility of one of the station employes slipping on the steps and falling toward the moving plungers. This hazard is of course greater during rainy weather or during the winter months when snow or sleet may blow on the steps and make them more slippery or when an operator hurries through the door as he is prone to do during inclement weather.

While the hazard is not one of extreme danger the Stanolind Pipe Line Co. built an inexpensive guard around the plungers to prevent serious injury should an employe fall down the steps toward the plungers. The material used in the construction of the guard is usually found in the racks of salvage material at the station's warehouse and may be made up quickly by a welder. The guards are so constructed that they may be bolted in place and are easily removed whenever necessary.

Two types of guards were built for the company's Humbolt, Kan., station and either may be used. Both are U-shaped and are made by fabricating 1¼-inch pipe. The top rail is bent to shape and cut to the desired length. The bottom or second guard rail is made in the same manner and is welded to the upright braces on either side. Another brace is welded between the rails on the closed end and another short length, flattened at one end with a bolt hole drilled in the flat end, is welded to the bottom rail. The flat end is bolted to the plunger slide base. The free ends of the top rail are bolted to the pump to make the guard rigid.

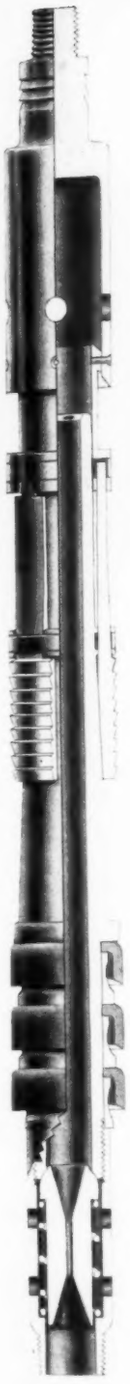
One side is bolted to the flange on the pump's air chamber and special clamp was made to bolt the other end of the rail to the pump's suction line, which is a radius bend coming from the pump to the header below the floor. The clamp is made with strap iron fashioned to fit around the pipe and its two free ends are drawn together with a bolt. The end of the top rail extending to the suction line is bolted to the clamp.



Rail type guard bolted to pump.

Where an apron is used on the guard the second rail is not necessary. An angle iron frame is fashioned and welded to the top rail at the joints. The sheet metal is tack welded to the rail at the top and riveted to the angle iron frame on the bottom and at the ends.

Either guard provides for ample room at the closed ends so there is no chance for a hand to be mashed on the outward stroke of the plunger. In addition to forming a guard in the event an operator should fall from the steps the guards also protect employes should they slip while walking around the plungers.



Patented and Patents Pending

RUNNING POSITION

THE

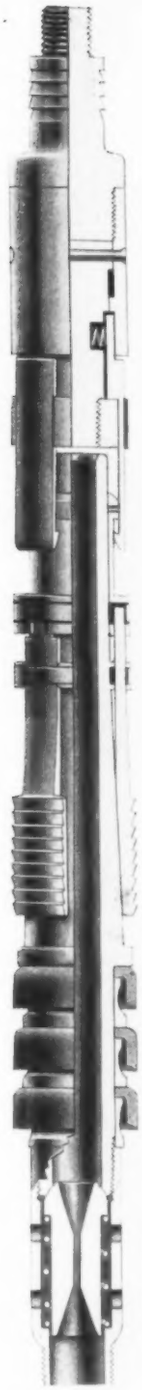
OTIS REMOVABLE BOTTOM HOLE CHOKE

has already extended the flowing life of this well more than six months, although the well is surrounded by pumping offsets!

●

The Well:
Deep Rock Oil Company's
W.W. Holland No.1
Joinerville Area
East Texas

●



Patented and Patents Pending

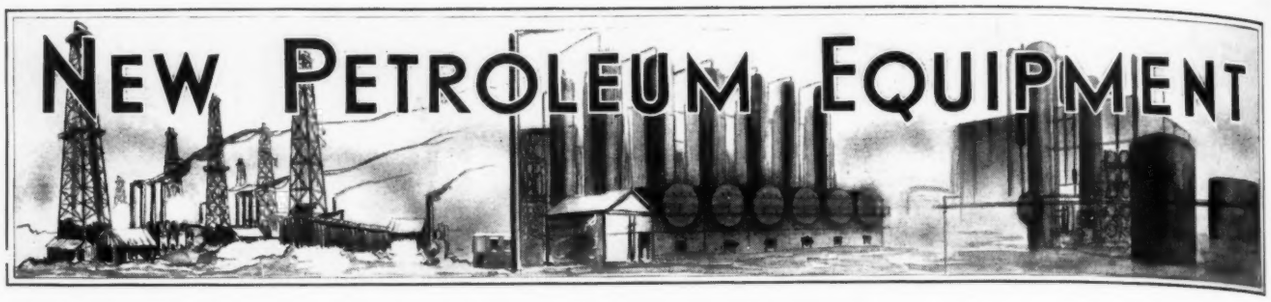
PULLING POSITION

THE SOUTHERN STATES COMPANY, INC.

Shreveport, Louisiana

●

● Installations made on trial basis ●



Kennedye Oil Field Devices

KENNEDYE Oil Field Devices Company, 6100 Manchester, St. Louis, Mo., has placed two new products on the market. They are the Kennedye sucker rod "Boots" and the Kennedye folding wax preventers.

It is claimed that the sucker rod "boots" will eliminate 50 to 80 per cent of all rod and tubing troubles caused by metal-to-metal wear and at the same time reduce the power necessary to raise a given column of oil and reduce whipping of rods.

Kennedye "boots", a small device designed for minimum friction, weight and restriction, is clamped around the sucker rod string, thus absorbing all the wear normally imposed on the rod and tubing as they scrape against each other. "Boots" are made of frictionless alloy designed to resist wear and will not scrape the tubing. A number of very interesting field records have been made by the devices where an unusual amount of trouble was being experienced.

The Kennedye wax preventers are designed to prevent wax accumulation in the tubing. They are attached to the sucker rods and are so designed that the blades shave the tubing on the upward stroke and fold to prevent friction on the downward stroke. The blades are set at a 30-degree angle to avoid hanging up at the tubing joints. These may be used as companions to the Kennedye sucker rod "boots". They are priced at $288.00 per gross for ¾-inch rods and 2½-inch tubing.

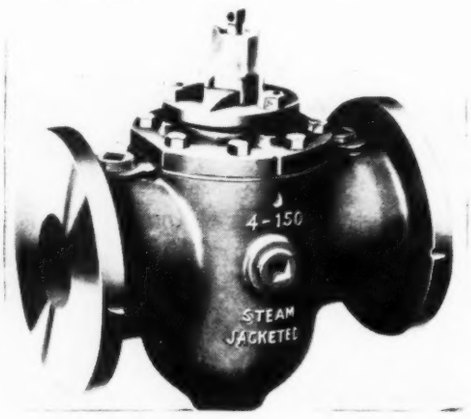
Full particulars of these two new devices may be secured from the Kennedye Oil Field Devices Company.

Steam Jacketed Valves Developed by Nordstrom

FOR use in conjunction with steam-jacketed piping, a new series of Nordstrom steam-jacketed valves has been developed and offered in semi-steel in sizes from 2- to 4-inch, inclusive.

These valves are rated at 150 pounds line working pressure and the jackets are designed for a maximum saturated steam pressure of 100 pounds, with maximum temperature 337 degrees Fahrenheit, according to the manufacturers, Merco Nordstrom Valve Co.

The Nordstrom valve embodies a lubricated plug cock, and, by use of the steam jacket housing, permits the handling of fluids of highly viscous nature, or requiring an elevated temperature for proper transmission. These valves are cast with a double walled body, the heating space thus formed entirely surrounding the body. To accommodate the double wall and jacket space and to provide proper clearance for bolting, the valve is cast for flanges larger in diameter than normally used.



The valve flanges have the standard dimensions of the next larger standard pipe size, so that no special drilling templates are required.

Special lubricants in stock form have been developed by the company for use in valves carrying high temperatures, so that the lubricant retains the proper consistency and provides the correct film between the plug and its body.

Specifications of these steam-jacketed valves may be had by addressing the manufacturers, 343 Sansome St., San Francisco, or any of the branch offices.

Boiler Feed-Water Regulator

A NEW boiler feed-water regulator has been developed by G. W. Volz, and is to be manufactured and distributed by J. A. Campbell Co., Long Beach, California. The regulator, claimed to be self-compensating for variations in atmospheric temperature and boiler pressure, has only one moving part and is automatic in action.

The Volz feed-water regulator consists essentially of two expansion tubes connected into a body casting and meeting at their outer extremities in a close return-bend. The lower tube is the working element and the upper tube the compensating element. The return bend carries a lug, to which the valve linkage is attached; and the expansion and contraction of the working tube induced by slight changes in water-level is multiplied and translated into vertical movement, which is directly transmitted to the valve stem.

The water-level mark on the main body of the regulator is set on the same elevation as the desired boiler water-level. A connection is brought from the boiler water-level, both meeting at the regulator body. The two expansion tubes leading from the regulator body are of extra-heavy brass pipe and converge in a brass return-bend casting, with a lever connection for operating a balanced valve.

Gasket Material Compound

A NEW gasket material, moisture-proof, and highly oil-resistant, has been announced for sale by the General Electric Company. This material, known as No. 1000 Compound, is recommended especially for applications where the primary purpose of the gasket is to exclude moisture.

It is a white, odorless, sulphur-free rubber compound, available both in sheets and moulded shapes. It is extremely tough and strong, very flexible, requires no sticker, and can be used repeatedly in testing work, as well as in permanent joints.

This material has been found especially useful in making joints in porcelain and metal assemblies, such as dry-type bushings for outdoor transformers and oil circuit breakers. It is used effectively, also, in terminal potheads for lead-covered cables.

It is unaffected by exposure to the weather, and when under compression in properly-made joints, is not attacked by cold oil. In contact with hot oil it is practically unaffected where enclosed in recessed joints under compression, but is not generally recommended where resistance to hot oil is of prime importance.

Further details of this new gasket material compound may be secured by writing to the General Electric Company, Schenectady, New York.

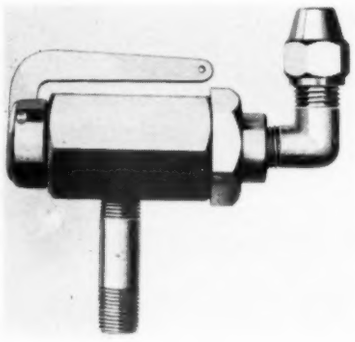
Griptite Belt Dressing

A NEWLY developed dressing, known as Griptite belt dressing, for rubber belts, has been placed on the market by the Diamond Rubber Co., Inc., Akron, Ohio.

This dressing is not greasy, inflammable, nor harmful to belt or pulley, the makers claim. It is said that immediately upon application it doubles the pulling power of the belt, and its effectiveness increases with use.

P-O-L Primer for Engine Starting

THE P-O-L Primer, a unique device for facilitating the starting of gasoline engines, either automobile or stationary, has just been introduced by the Linde Air Products Company, 30 East 42nd St., New York, N. Y. The primer is a simple and easily installed device for introducing acetylene, a highly combustible gas, into the cylinders of an internal combustion engine so that it will start easily.

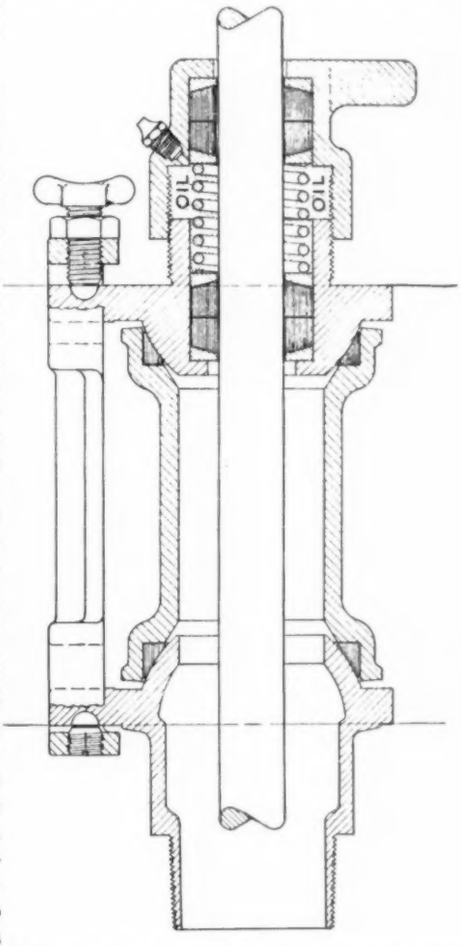


The primer consists, essentially, of a special stem-type brass primer valve, a Prest-O-Lite pressure regulator and 10 feet of ¼-inch brass tubing with compression unions. The primer valve is mounted on the intake manifold of the engine, the regulator attached to the tank valve and the two connected with the ¼-inch brass tubing. The regulator automatically reduces the tank pressure of the acetylene to a low line pressure and the primer valve controls its flow into the manifold. The valve is operated by a pull wire which leads from the valve lever through the dash if the vehicle has a self-starter, or through the radiator if hand-cranking is employed. On a stationary engine the pull wire may lead to any point that is convenient when cranking.

In starting an engine on which the P-O-L Primer has been installed, the usual procedure of spark and gas adjustment is followed except that the P-O-L Primer is used instead of the full choke. Instead of raw gasoline, the primer introduces into the cylinder combustible acetylene which fires easily and quickly and the engine turns over at once.

Hill and Foster "Folorod" Device

THE Hill and Foster Company, Wichita Falls, Tex., recently announced a stuffing box designed to alleviate the lateral stress on stuffing box packing and to supply a lubricant to the polished rod at all times.



The stresses are alleviated by allowing the box to follow the rod in its various movements, hence the name Folorod has been given the box. The lateral motion of the rod is controlled by shoulders arranged in the ball joints so that the travel is limited to the difference between the diameter of the rod and the inside diameter of the tubing. A bath of oil is provided by dividing the packing and filling the space between the packing with a suitable lubricant through an alemite cup, so that at all times the polish rod will be covered with a film of protection from friction as well as the action of salt water and other chemicals present in the fluid pumped.

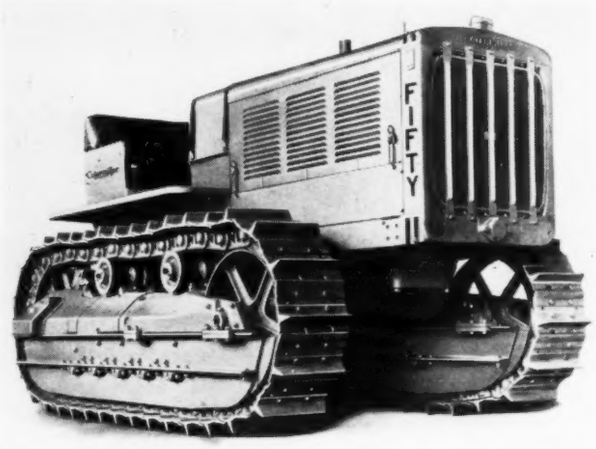
At the same time the company is marketing a device known as the Folorod attachment to be used in connection with an ordinary stuffing box. In place of the stuffing box in the top flange of the Folorod, the Folorod attachment has regular tubing threads into which an ordinary stuffing box may be screwed. This alleviates the lateral stresses, but does not give the benefits of a lubricated polished rod.

Caterpillar Fifty Tractor

THE Caterpillar Fifty Tractor has been developed by the Caterpillar Tractor Company, Peoria, Ill., to serve new markets, and it takes its place in the Caterpillar line between the Thirty and Sixty in size.

This tractor develops 50 horsepower and offers the latest accumulation of Caterpillar engineering skill and tractor-building experience. The tractor has four forward speeds, with a per mile speed ranging from 1.6 to 4.7 per hour. Its drawbar pull in pounds at governed speed and maximum drawbar horsepower (sea level) ranges from 11,800 pounds in first to 3,985 pounds in fourth gear.

The engine is a four-cylinder, four-cycle, water-cooled, valve-in-head type, having a bore of 5½ inches and a stroke of 6½ inches. The width of the track shoe is 15



inches, which is bolted together with ⅝-inch bolts. The length of the tracks on the ground is 81⅞ inches.

The over-all dimensions of the tractor include a length of 146¼ inches, a height of 75¾ inches and a width of 78⅞ inches. The ground clearance at the lowest point is 11¼ inches.

Mid-West Welding Head

THE Midwest welding head has many advantages. Its ellipsoidal form of the Midwest welding head reduces the unit stress in the metal to a minimum. But what is perhaps more important, the circumferential weld to the pipe is entirely in tension as a result of the long tangent of the head; this weld is not subjected to shear and bending.

The dimensional accuracy, the long tangent and the end beveled 45 degrees for butt welding, make the application much easier. Where a neat appearance is desirable, the head offers this advantage, also.

A wide variety of sizes are carried in stock to permit quick shipment, but special orders may be easily secured.

These welding heads are the products of the Midwest Piping and Supply Company, Inc., Saint Louis, Mo.

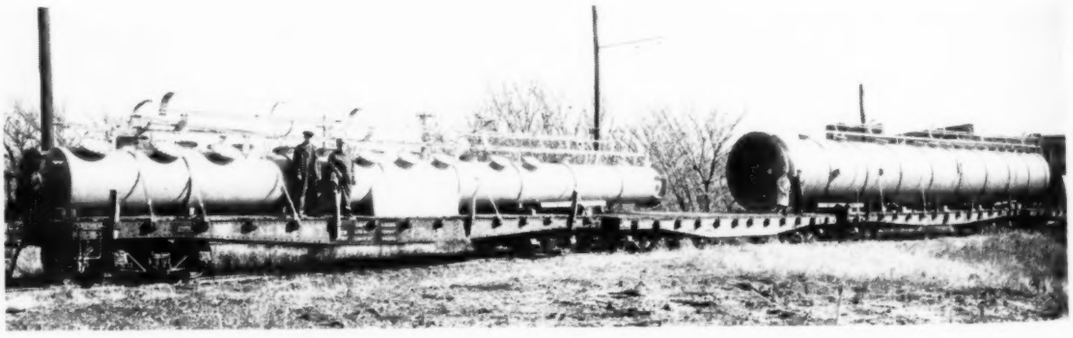
Shaffer Bull Dog Pump Jack

SHAFFER TOOL WORKS, Brea, Calif., has just placed on the market the Shaffer Bull Dog Pump Jack. The makers claim it has unusual smoothness of operation because of the weight of the rods being carried at all times by an air cushion which acts similar to automobile shock absorbers, thus eliminating the shock or whip of the rods. Counterbalancing is achieved by means of air pressure with a small air compressor.

The balance is adjusted to a nicety by setting the air pressure to the right point. This can be done without stopping the well. The pump jack folds back when the well is to be pulled.

Interesting Welding Job Handled by American Tank

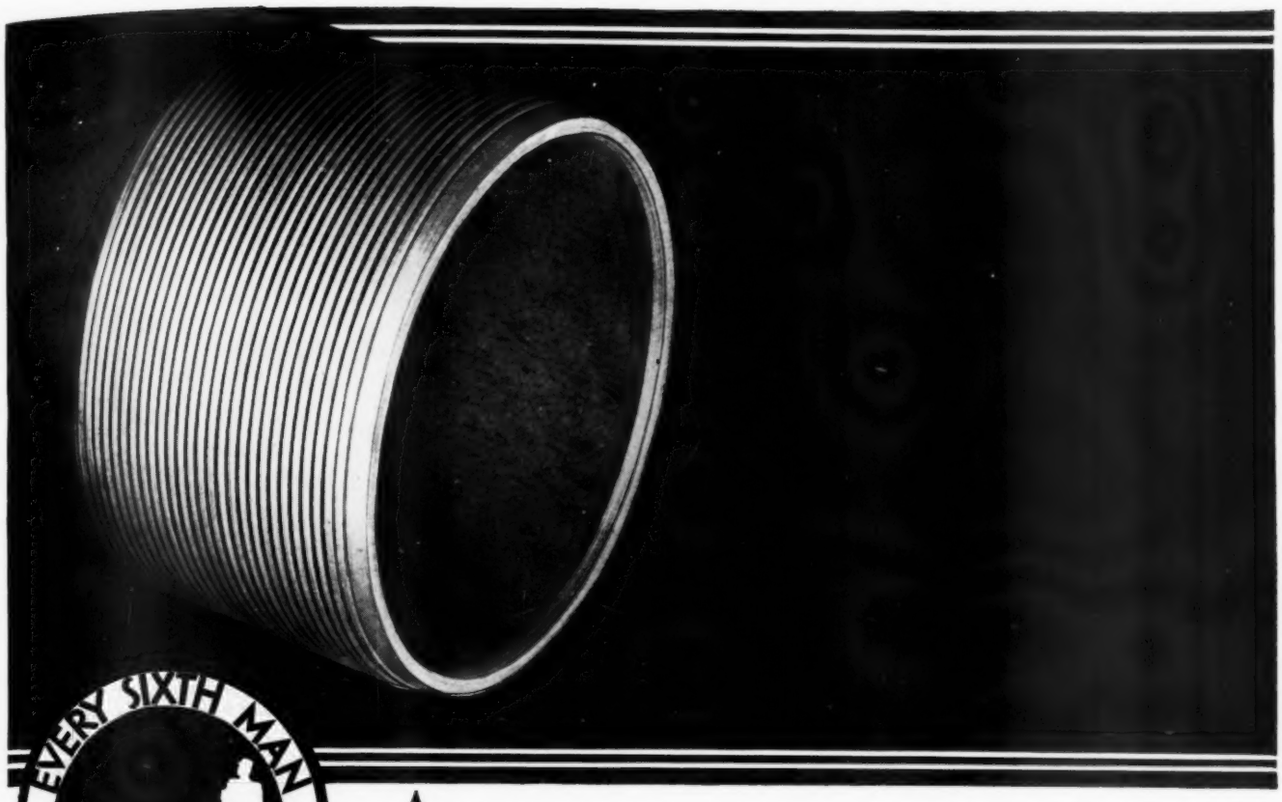
A HEAVY pressure vessel and welding job of interest were completed at the shop of the American Tank & Equipment Corporation, Oklahoma City, Okla., the manufacturing subsidiary of Black, Sivalls & Bryson of Bartlesville, Okla., recently.



The shipment was to the Octane Oil Refining Company, Chautauqua, Texas, for a new 1,400-barrel refinery. The towers were engineered by the A. J. Smith Company of Kansas City. Four cars were required to transport the shipment.

The largest vessel was a nine-foot diameter by 76-foot 4-inch long reducing tower and vaporizer, complete with trays. This vessel weighed 101,959 pounds. In addition there was a four-foot diameter by 60-foot topping tower and a three-foot diameter by 40-foot long absorber tower and a five-foot six-inch diameter by 15-foot six-inch gas separator. The weight of the topping tower was 26,127 pounds, the gas separator 5,800 pounds and the absorber tower 9,585 pounds.

The welded vessels manufactured for this installation were entirely "BS&B Flexwelded," a welding process developed by the research department of Black, Sivalls & Bryson.



Five men out of every six in the J&L Seamless Tube Department make the Seamless — the sixth man inspects it. He looks for trouble and flaws, so you won't have to. He's on our payroll — but he works for you. He's one of the many reasons why J & L Seamless stands so high in the estimation of every user.

A pipe thread is only a fraction of an inch wide and a fraction of an inch deep, yet it is frequently called on to take the titanic strain of lifting a mile of casing. Failure may mean the loss of tens of thousands of dollars. The thread *must* hold — and J & L spares no pains nor efforts to insure that it will.

J & L Seamless Pipe threads are smooth and accurate, with a bevel that means easy stabbing. Running the Seamless together, and breaking the joints, are both accomplished quickly and easily. There is no raggedness to cause turned threads; strings of casing, tubing and drill pipe may be made up time after time. The threads, smooth and accurate originally, stay that way.

The care taken in making and inspecting threads on J & L Seamless Pipe is typical of the care with which every operation in the manufacture of J & L pipe is carried out. The result is a product of uniform quality that will give you dependable service, and long time satisfaction.

JONES & LAUGHLIN STEEL CORPORATION

AMERICAN IRON AND STEEL WORKS

JONES & LAUGHLIN BUILDING, PITTSBURGH, PENNSYLVANIA

Manufacturers of Seamless and Welded Casing, Tubing, Drill Pipe and Line Pipe, and Welded Steam, Gas and Water Pipe in both Black and Galvanized

Also makers of Bars, Shapes and Plates, Reinforcing Bars, Cold Finished Steel, Junior Beams, Steel Piling, Fabricated Structural Work, Steel Barges, Wire Products and Tin Mill Products

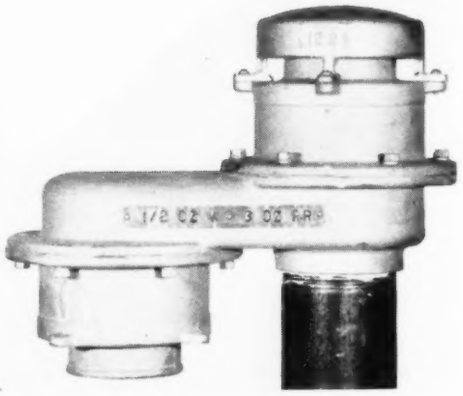
J&L STEEL

Storage Tank Valve Equipment

THE Columbian Steel Tank Company of Kansas City, Mo., has developed several products in the valve line for oil field storage tanks.

Among the developments is a plain thief hatch, which is non-sparking, vapor-tight and corrosion-proof under all conditions. The lid raises at four ounces pressure.

A vacuum pressure thief hatch is another new development. It is also corrosion-proof, vapor-tight and non-sparking, and a most compact triple-service piece of mechanism. Its pressure range may be adjusted from 4 to 16 ounces and the vacuum valve opens at one-half ounce. This piece of equipment has no rubber gaskets, being all-metal. The valve mechanism is springless, the vacuum valve consisting of a counterbalanced vacuum plate.



The new Columbian vacuum pressure valve device works perfectly even under sour oil conditions. Bakelite is used for the valves and valve seats. All working parts are corrosion-proof. The pressure valve opens at 3 ounces pressure and the vacuum valve at one-half ounce.

The valve parts are interchangeable and either valve may be removed from the main housing and adapted individually in any position desired. It is built regularly for four-inch pipe connection.

Unit-Built Motors and Speed Reducers

AN extremely simple, compact and efficient arrangement for powering various motor-driven equipment which operates at reduced motor speeds is afforded by new unit drives available from the Westinghouse Electric and Manufacturing Company, Nuttall Works, Pittsburgh, Pa.

These new drives which are known as Gearmotors, consist of speed reducers combined with motors forming self-contained units only a few inches longer overall than motors alone. Prominent advantages afforded by this combination of power and speed reducing equipment include economy in space requirements, easy and simplified installation, reduced number of drive parts, high efficiency of operation, and assured low maintenance requirements.

Each unit includes a Westinghouse type CS general purpose induction motor and double reduction, non-planetary type helical gear speed reducer built onto the one-piece motor frame, forming a sturdy and rigid assembly which is supported entirely by the motor feet.

An outstanding improvement in motor construction incorporated in these unit drives is the pre-wound primary core which is separable from the stator frame.

The desired reduction of motor speed is obtained smoothly and quietly by helical gears and pinions, the teeth of which are cut to a high degree of accuracy by the hobbing process.

Fischer Multi-Seat Gauge Cock

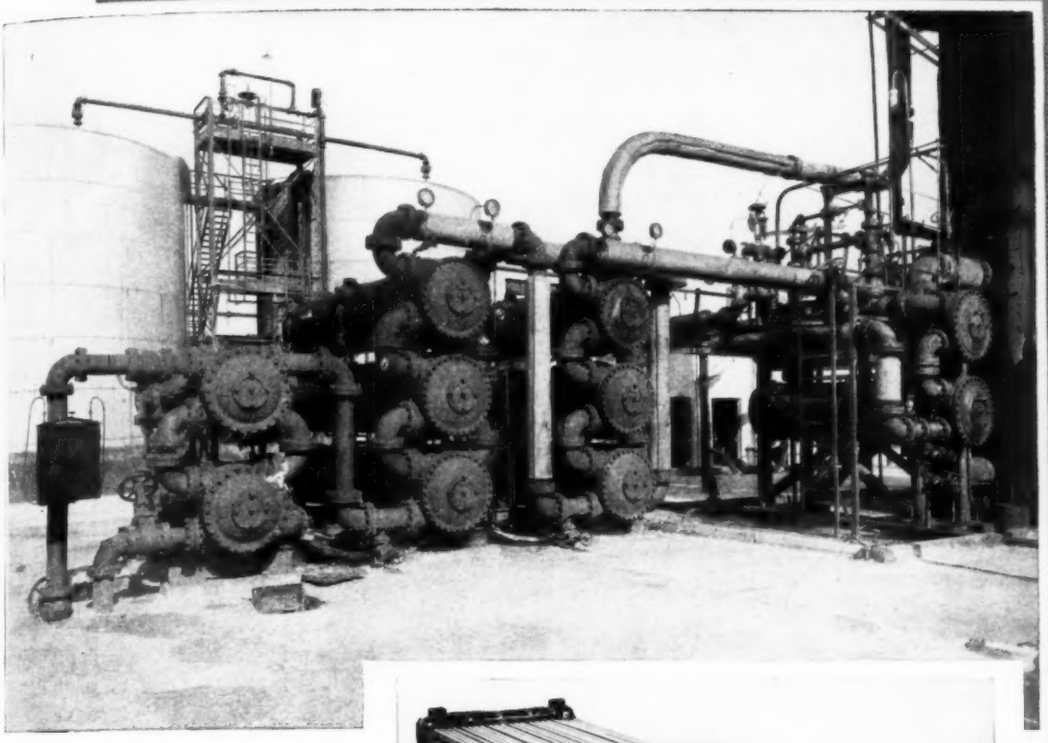
A GAUGE cock which employs a large free-wheeling lead ball with space for thousands of seats, has been developed and patented by the C. A. Fischer Company of Fort Worth, Texas. This gauge cock has been tested to withstand 1400 pounds pressure, providing a four-to-one safety factor on 350-pound boilers.

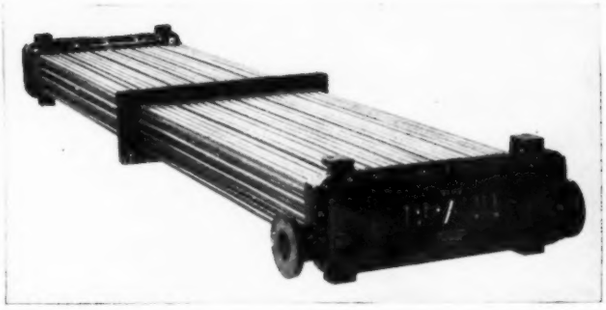
The lead ball is of such analysis that it is relatively soft, permitting unlimited repeating and over-lapping of seats, thereby giving the cock an indefinitely long life. The ball is loosely held in bronze ball holders so it automatically reseats in different spots each time it is raised and lowered, thus becoming free-wheeling and offering a multi-seat feature without leakage.

The stob or nozzle has a wrench section 1½ inches long and is made of special nickel phosphor bronze alloy which produces an extra hard, tough tip to resist battering, corrosion and erosion. The hinge bolt is of special analysis steel and is heat treated to provide maximum strength, ductility, shear and impact resistance. Both bolts and nuts are cadmium-plated to prevent corrosion.

The long stout hinge lugs on the bronze ball holder deflect the steam and water spray against the boiler until the fireman's hand is well out of the steam and water line, as the handle is set at the proper angle to prevent burning.

LET TONCAN RELIEVE YOU OF CORROSION TROUBLES





Top—Absorption plant as manufactured by the C. F. Braun Corp., Alhambra, Calif. All units in photo use standard Toncan Iron Pipe for tubes.

Right—Expansive type cooling sections as used in gasoline absorption plants. All tubes are standard Toncan Iron Pipe.

Pipe corrosion and costly plant "shutdowns" go hand in hand. Yet these expensive non-productive periods are largely unnecessary since the introduction of Toncan Iron Pipe.

This statement is borne out by the experience of plant operators and is further attested by the results obtained in service from the equipment of many manufacturers of refinery units. Test after test has demonstrated that in lines and equipment where the life of non-alloy ferrous pipe is sometimes measurable in days, Toncan Iron Pipe, after months of service, shows no corrosion, no pitting, no appreciable loss in weight.

Toncan Iron is an alloy of refined iron, copper and molybdenum. Its resistance to corrosion is an acknowledged fact. In still lines, condensers, acid sludge lines, absorption units—underground or exposed to the elements—Toncan Iron Pipe may be the answer to the ever present problem "How can we minimize 'shutdown' losses?"

"Pipe for Permanence" is the name of a book that will interest every refinery operator—every maker of refinery equipment using pipe. Gladly mailed on request.

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TONCAN
COPPER
MO-LYB-DEN-UM
IRON PIPE

REPUBLIC STEEL CORPORATION

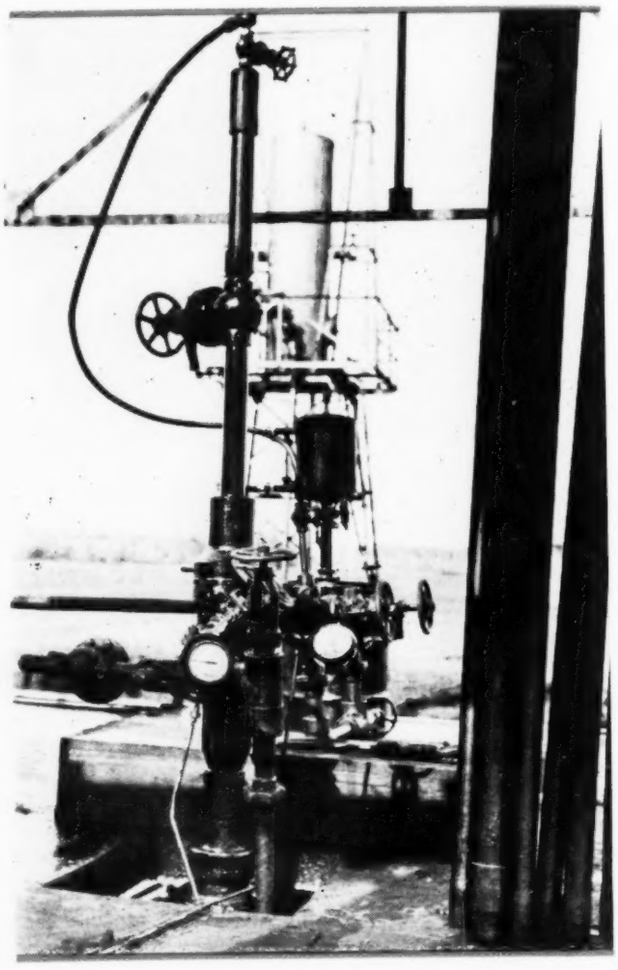
GENERAL OFFICES YOUNGSTOWN, OHIO

Simple Principles Adapted to
Pump *with* Free-Traveling Plunger
Making It Automatic in Operation

By H. W. FLETCHER, *Chief Engineer, Hughes Tool Company, Houston, Texas*

ABOUT eight years ago the Hughes Tool Company began a series of experiments to develop a new method of lifting fluid from deep wells that would be economical and free from the disadvantages of lifting systems requiring pressures of 1,000 to 1,500 pounds per square inch. As a result a new process of raising fluid has been evolved, the apparatus of which is a radical departure from orthodox pumping systems.

The only moving part of the apparatus is a free hollow plunger that travels the entire length of the tubing from the footpiece to the flow head. The plunger is actuated by gas pressure either from the producing formation or from an outside source through the casing. Once regulated, the plunger-lift is automatic in operation.



Surface equipment of the Hughes plunger lift.

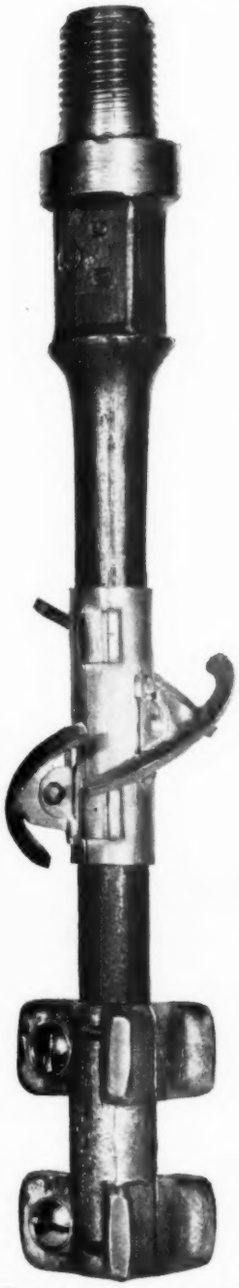
An illustration accompanying this article shows the apparatus installed in a well. It consists of a special string of reamed tubing supported in a flow head and carrying a footpiece at the lower end. The tubing must be truly round and of accurate internal diameter, but not necessarily highly polished. To avoid any offset in the bore of the two pipe ends joined by the coupling, the coupling threads must be in accurate alignment, which requirement precludes the use of commercial pipe and couplings. The pipe must be reamed full length to obtain the necessary accuracy. Traveling in this tubing is a free plunger of stainless steel or similar corrosion-resisting material. It is a hollow shell fitted at the lower end with a dart-shaped check valve loosely held in place by a cage attached to the lower end of the plunger sleeve. To deaden the impact of the plunger the footpiece has a cushion seat. A hole in the cushion seat, through which the fluid enters the tubing, is large enough to fit loosely the stem of the valve in the plunger. A packer may be used below the footpiece if required. Longitudinal slots are cut in the tubing, to form a nozzle where it passes through the flow head at the surface, for the fluid to pass into the flow line. The tubing extends above the flow head for about eight feet and forms a stack and a surge chamber with a valve between (see illustration). The surge chamber, with the valve below, provides a means of examining the plunger or replacing it if necessary.

After the tubing with footpiece is run in and the latter placed at the desired depth below the estimated working or pumping level of the well, the surface equipment is assembled as shown in illustration, with the plunger inserted in the surge chamber. By slowly opening the plunger trip valve below the surge chamber a little more than half way the check valve in the plunger falls to the open position by gravity, after which the gate valve is opened full and the plunger released. It falls with an average velocity of 40 to 50 feet per second until it strikes the fluid level, and then six to eight feet per second until it reaches the cushion seat in the footpiece. The valve in the plunger is so designed that it will not close while falling in the tubing through either gas or liquid. As the plunger reaches the footpiece it seals the opening in the cushion valve and, if the well has not reached its static fluid level in the tubing, the pressure will immediately begin to build up below the plunger. Only a few pounds pressure is sufficient to raise the plunger valve to its closed position and any further increase in pressure is then exerted over the full cross-section of the plunger, which is raised with its load of fluid to the surface. When the top of the fluid column reaches the slots in the nozzle, the fluid spills off into the flow line and as the load is reduced the plunger rises with increasing speed to the surface. Some oil accumulates in the stack directly above the nozzle and as the plunger strikes the oil after passing the slots the pressure set up in the hollow body of the plunger opens the plunger valve and allows the plunger to fall again to bottom.

If during the installation of the apparatus the well has reached its static fluid level in the tubing or has "loaded up" so that the well pressure acting on the bottom of the plunger is not great enough to start the plunger with its load upward, it may be necessary to reduce the head of

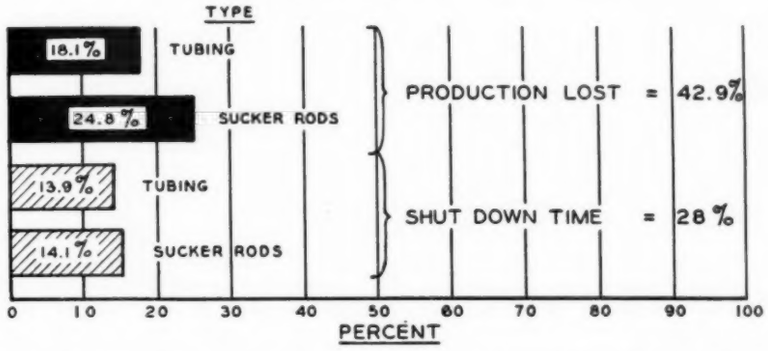
GULF RESEARCH LABORATORIES TREATISE ON SUCKER ROD AND WELL TROUBLES

Yours for the asking. Through the courtesy of the above and this journal, we have arranged reprints for you. Write us for your copy.

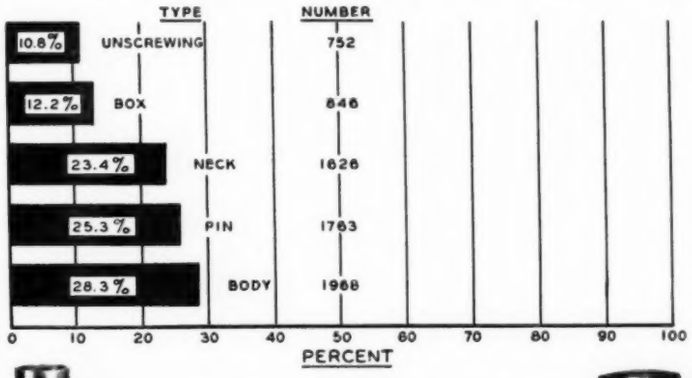


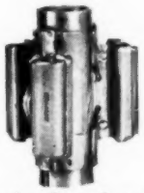
This is the way the "Boots" and Wax Preventers work.
¾" and ⅞" rods.
2½" and 3" tubing.

Analysis of well trouble for 1930 in Mid-Continent Operations.

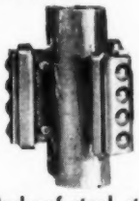


Classification of Sucker Rod failures in Texas and Louisiana wells for 1930.





Body of steel, stainless. Inserts of "Gramix", bronze or hard rubber.



Body of steel, stainless. Stainless balls incased in special bronze housing.

East Texas Crude Congeals at 53° F but flows freely when agitated. KENNEDYE WAX PREVENTERS keep it agitated at no additional cost.

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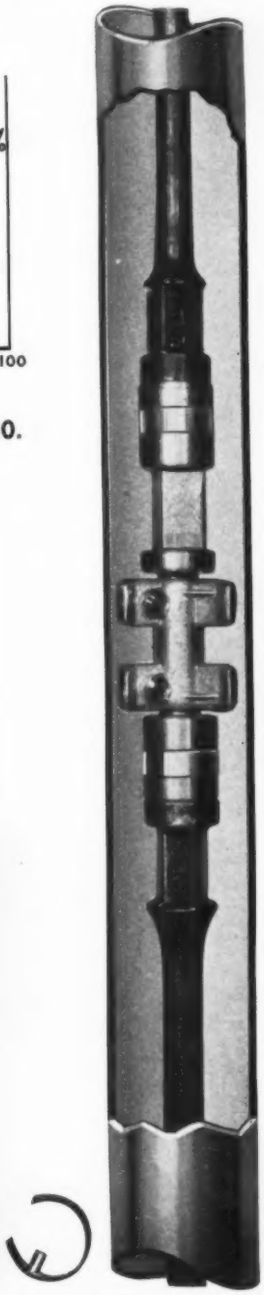

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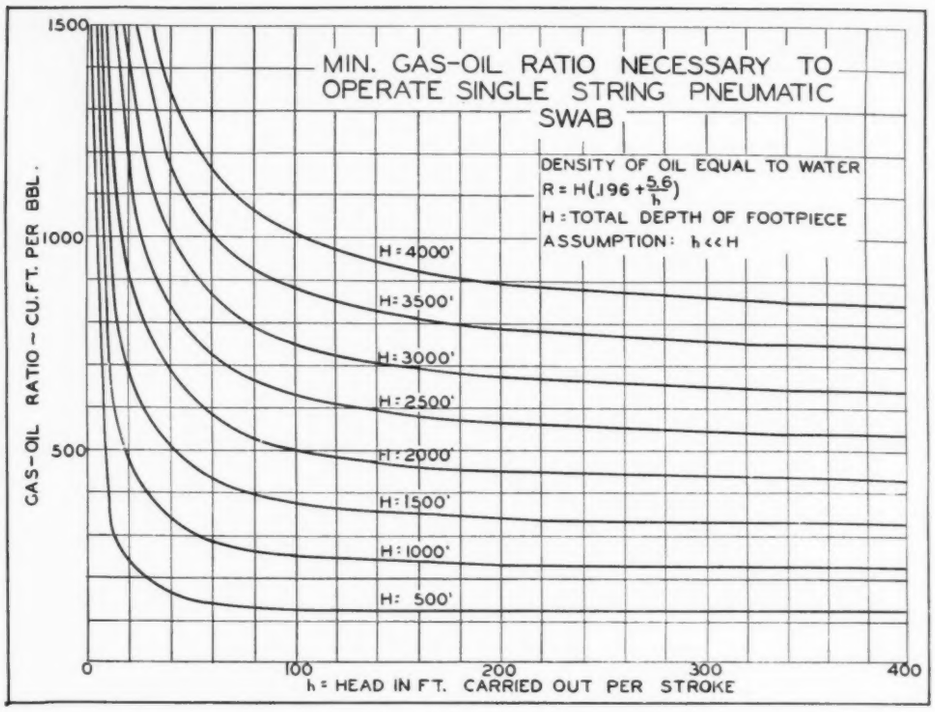
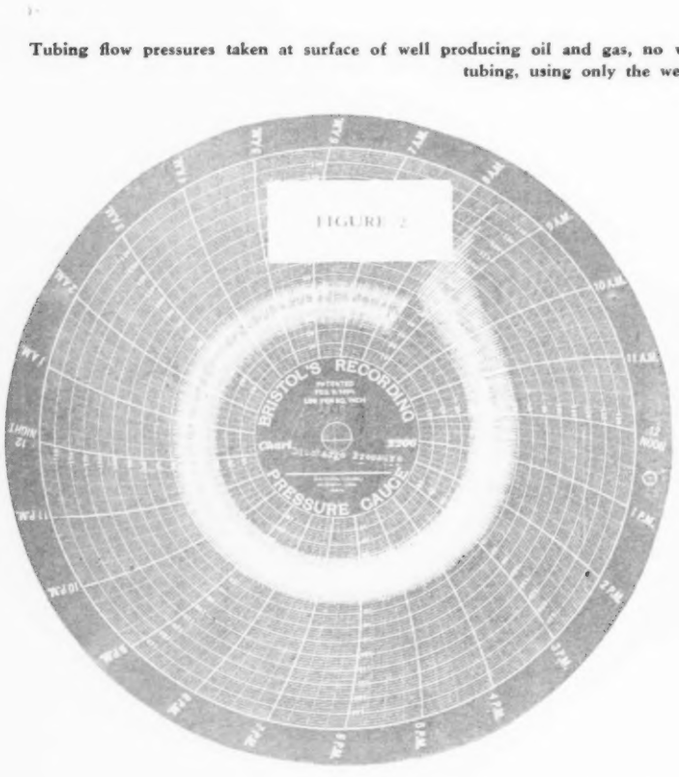
fluid in the tubing by swabbing, or by supplying gas from an outside source through the casing and into the tubing to get the well started. When the well starts to produce, the successive heads of fluid lifted become smaller and smaller until that point is reached where the fluid comes into the well at the same rate at which it is removed, after which a uniform quantity of fluid per stroke is discharged with astonishing regularity.



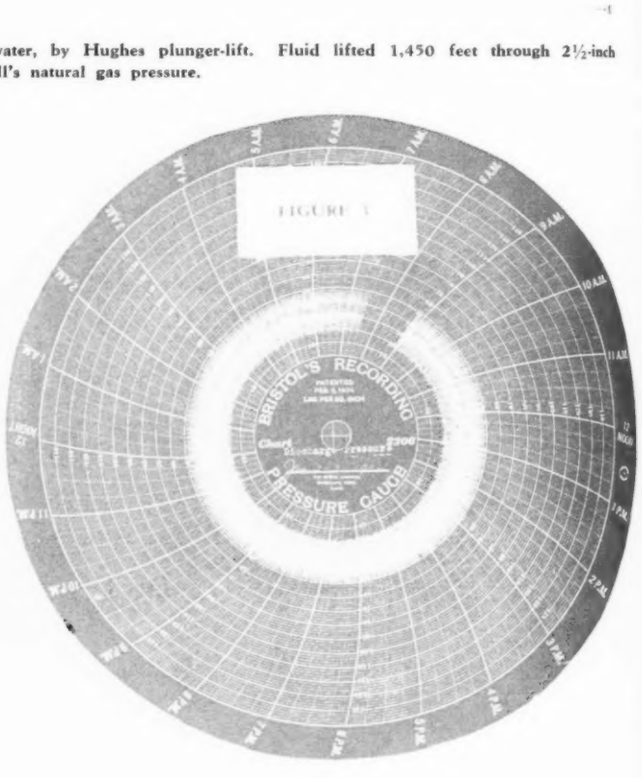
Two pressure charts taken from the discharge of an oil well in which the equipment was in operation are shown in the accompanying illustrations. One was taken when the well started up at 8:20 a. m. after a Sunday shutdown; the other was obtained on the last day of that same week. The first chart shows that within three hours of starting up a good part of the accumulated head was pumped off and thereafter the rate of pressure reduction was gradual and remarkably uniform. The second chart illustrates the steady operation of the well after it had settled down. This well was produced with only the natural gas in the formation, without any extraneous aid.

As almost the entire length of the tubing must be filled with gas each stroke to a pressure equal to that on the bottom of the plunger at the time the plunger reaches the nozzle, the quantity of gas required depends mainly on the distance through which the load is lifted. In addition, there is a loss of gas while the plunger is falling that can be estimated closely from the percentage of total cycle time during which the plunger is falling. It is not necessary that the plunger fit the tubing closely, for the difference of pressure tending to force

Tubing flow pressures taken at surface of well producing oil and gas, no water, by Hughes plunger-lift. Fluid lifted 1,450 feet through 2½-inch tubing, using only the well's natural gas pressure.



Well started up 8:20 a. m. after Sunday shutdown. Note how quickly head was reduced first three hours and gradual but regular rate of reduction thereafter.



Record taken on last day of same week. This illustrates the steady operation after working level has been established in the well.

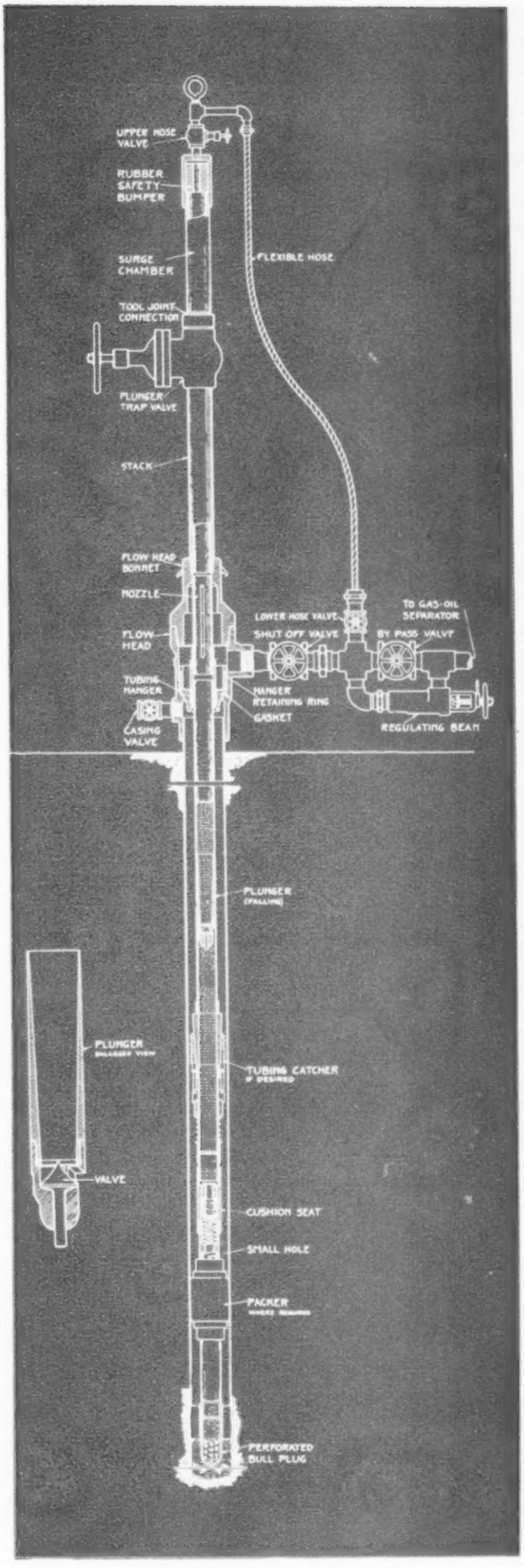
gas past the plunger is only that required to support the weight of the plunger alone—a matter of only a few pounds; also in traveling up the pipe a film of fluid is continuously wiped into the space between the plunger and tubing, maintaining a fluid seal that effectively prevents gas leakage at so small a pressure difference. The series of curves presented shows the volume of free gas required per barrel of fluid to fill the tubing from footpiece to flow head to a pressure 20 per cent (the amount allowed to overcome friction) in excess of that required to counterbalance the weight of the fluid lifted, disregarding the expansion of the gas in the tubing which takes place when the head of oil lifted each stroke is an appreciable percentage of the total lift. Nor do the curves take into account the loss of gas while the plunger is falling. This must be estimated by the method already indicated.

If the submergence of the footpiece were so small that only a teacupful of fluid were picked up each stroke, it is obvious that the gas-oil ratio would be enormous, for the entire length of tubing is filled with gas each stroke at a pressure slightly above atmosphere to produce a negligible quantity of fluid. On the other hand, the curves indicate that for relatively shallow wells not much reduction in gas-oil ratio can be obtained by picking up more than about 200 feet of fluid per stroke. In extremely deep wells a slightly greater reduction in gas-oil ratio could be obtained by picking up a greater load than this each stroke. The question of the most desirable bottom-hole pressure, hence the best working fluid level, would probably be an important consideration in deep wells. This in turn would control the decision also as to the most economical head of fluid to be picked up each stroke. With regard to the curves, it should be observed that a load of liquid not saturated with gas is assumed. The fact that the average oil carries considerable quantities of gas in solution would indicate that the actual length of the fluid column would be greater than that shown, for as the fluid rises in the tubing to the nozzle the gas coming out of solution because of the reduced pressure would expand, thus lengthening the column of fluid. For wells of 3,500 feet or less in depth the lifting pressures need not greatly exceed 100 pounds per square inch unless it is desired to produce more fluid than can be handled at this pressure.

Field experiments to date have demonstrated that 500 cubic feet of gas per barrel of fluid for each 1,000 feet of lift is ample to maintain steady operation. Several experiments have been made where considerably less than 300 cubic feet of gas per barrel of fluid per 1,000 feet of lift gave satisfactory results.

The operation of the equipment is inherently stable; that is, the apparatus automatically adjusts the height of the fluid column picked up each stroke to a point where the available gas is just sufficient to supply the requirements. Any reduction in gas supply increases the fluid picked up each stroke and, conversely, an increase in gas supply reduces the pick-up. If the gas supply from the well itself is insufficient for steady operation, an additional quantity of gas at the required pressure can be fed into the casing from an outside supply and injected into the tubing at any desired point through special check valves; or if a well has "loaded up," a small quantity of outside gas can be used to unload the tubing and thus give the plunger-lift a chance to begin operating.

Regulation of production is obtained mainly by adjusting the footpiece so as to maintain the desired back pressure at the bottom of the hole, but may be controlled to a considerable extent by regulation of the bean in the flow line, providing there is sufficient gas available to produce the well against a choke. As the total gas required per stroke



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Note in the photographic illustration above the essential parts of this hookup manufactured by J. H. McEvoy & Company: Standard McEvoy Casing Heads; a new type of Adjustable Choke which has a full opening when withdrawn; **an Adjustable Universal Ell which allows for adjustment of the length of the tree for ease of installation.** It obviates strain due to poor fittings and alignment by the men in the field.

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With the standard McEvoy Type C Universal Casing Head, it makes use of the standard slips in the head while tubing is being run. Also possible to use McEvoy Universal Safety Pressure Head in case of threatened danger. Allows for safe suspension by means of the slips. McEvoy equipment is tested to a cold water pressure of 2,000 pounds per square inch. With this type of hookup, it is possible to either wash the well in, or swab it in.

Write for Complete Information on this Economical Hookup

•

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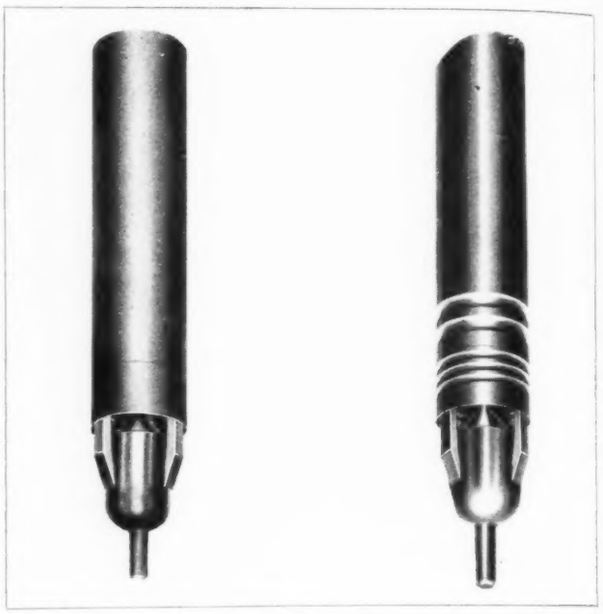
increases with the lifting pressure, it is obvious that if this pressure is raised by choking and the amount of fluid discharged per stroke is reduced, the gas-oil ratio required for operation must increase.

There is little about this apparatus to cause trouble, as the weight of the fluid lifted is supported by gas pressure and the plunger has a clearance of $\frac{1}{32}$-inch or more in the tubing. If for any reason the plunger has to be fished from the well, this is readily done by a light spear on a small line.

In normal operation the plunger may be removed for examination at any time. To do this the valve in the flow line is closed and the upper and lower valves on hose are opened. On the next discharge stroke the fluid discharges through the top of the surge chamber and the flexible hose, and the plunger follows it to the rubber safety bumper. As the plunger makes contact with the bumper, it seals off the gas and shuts the well in, the gas pressure below holding the plunger in place. The plunger trap valve may then be closed, the surge chamber unscrewed and the plunger removed for examination. This entire operation takes only five or ten minutes.



Standard plunger — Paraffin scraping plunger

FIGURE 5

A special plunger for scraping paraffin has been developed. It is illustrated along with the standard plunger. The plunger for scraping paraffin has made some very successful runs in wells where paraffin troubles are quite severe, the only attention required being to screw the flow bean in the discharge down to its seat and reset to the proper opening twice a day to prevent clogging of the discharge by paraffin from the tubing.

Where sufficient gas is available in the well to lift the fluid produced, the lifting cost will compare favorably with that of a flowing well. If gas is supplied from an extraneous source the lifting cost will depend on the cost of this supply. Where gas is not available, compressed air may be used if there is no salt water present to cause corrosion. Several experimental settings are usually required to determine the proper setting for the footpiece, but, once found, the apparatus will operate for long periods with a minimum of attention.

Tests on Steam-Driven Rotary Drilling Equipment

A THOROUGH and well-organized series of tests on steam-driven rotary drilling equipment has been carried out under the direction of the Special Research Committee on Prime Movers for Rotary Drilling and the information obtained is available in the special A. S. M. E. bulletin obtainable by writing to the A. S. M. E. office, 503 Tulsa Bldg., Tulsa, Okla., or 29 West 39th Street, New York City.

A deep well drilled with modern equipment in Oklahoma City was selected, fitted with test instruments, and records and observations made during the entire operation of drilling the well. A supplementary set of tests was made on a well drilled at Perry, Oklahoma, and equipped with a turbine-driven slush pump in order to investigate the possibilities of this new type of equipment.

At the Oklahoma City well indicators whereby continuous cards could be taken were fitted to the engine and to the steam and fluid ends of the slush pumps. Recording meters were placed on the gas and water lines and on the steam lines to the engines and pumps. Drilling was carried on at all times in a normal manner in order to obtain representative results. Test data, curves, and indicator cards are included in the above-mentioned bulletin.

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New Tourist Service Planned

A PLAN of selective service, designed to help dealers serving the motoring public, was announced recently by The National Association of Certified Dealers, a newly-organized association of independent retailers dealing with the traveling public. The association is identifying its dealer-members as offering "Certified Tourist Service" under a plan of major operation on every improved highway in the United States. It is claimed to be an organization founded for its members and run by the members. Headquarters are at St. Louis.

Among those businesses which will be selected to serve as units of the national organization will be filling stations, garages, hotels, tourist camps and restaurants. Through this national organization of dealers, every authorized member will be instantly recognized as an established unit, accruing to the benefit of every town and community, as well as to the motorist.

This association is backed by a group of men who have spent many years in sales and merchandising problems of dealers serving the motorist. These executives, as to integrity and ability, are vouched for by a large bank in St. Louis, a reputable firm of attorneys and a well-known firm of certified public accountants. The plan behind the association has received the endorsement of the United States Department of Commerce and Merle Thorpe, editor of Nation's Business.

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Neilan-Mason Open Joint Office

THE Neilan Co., Ltd. (Division of Mason Co.), and the Mason Regulator Co. announce the establishment of their own joint office at 409 E Archer Street, Tulsa, Okla. Gordon Thomason will be in charge of this branch office. Mr. Thomason is a seasoned control engineer and is widely known throughout the oil and gas industry. This new branch office will handle the sale of both Neilan and Mason instruments and regulators for the control of pressure, temperature and flow.

for increased capacity install

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COMPRESSION that escapes through the joint openings in ordinary rings—so small on each stroke that it may be difficult to detect—is a great loss of power, a costly waste of fuel. This has been demonstrated time and again by indicating the engine or compressor before and after installing COOKTITE Sealing Rings. Moreover, COOKTITES increase cylinder life as there is no blow-by to disturb lubrication. Even after cylinders are worn, the unit will "again act like new" by simply using several COOKTITES on each piston. Write today giving make of your Diesel, Gas Engine or Compressor and complete information will be sent you. No obligation, of course.

Compression leaks through the joint openings in ordinary rings.

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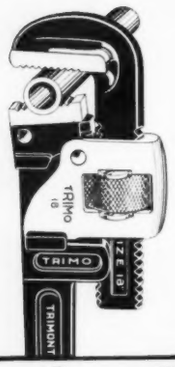

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TRIMO is made throughout by a company pledged for over forty years to fine tool making.

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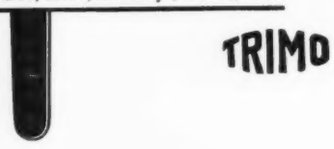

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The Probable Error in Meter Calculations

This is a discussion of the article by C. O. Johnson on the Theory and Practice of Orifice Measurement published in The Petroleum Engineer September, 1931.

The writer, Eugene Guman, is director of the Sonametan Company, Mediasch, Roumania. He is a practical gas man having had many years experience in the natural gas industry in that country. This discussion should be of great interest to those operating men interested in gas measurement.

IN his article, appearing in The Petroleum Engineer for September, 1931, C. O. Johnson has pointed out the mechanism which records the two basic factors, the differential, and the static pressure; in its actual development it is of very high sensibility and precision but the calculating methods in use to determine the gas flow from these two elements recorded on the orifice meter chart leaves much to be said.

The most common and widely used method is that with the extension tables: the calculator averages from the chart the mean hourly differential and static pressures, takes the corresponding square roots from the extension table, sums it, and multiplies with the orifice co-efficient.

Obviously the "hourly average" is the arithmetic mean of the curve recorded on the chart, because it is impossible to estimate in square root so that the calculator reads off the diagram a very near value to the arithmetic mean.

For a better demonstration let us take the simpler case when the static pressure remains constant and only the differential pressure varies with the consumption. Let us consider the differential record transplotted in a Cartesian co-ordinate system, where the abscissa is the time t the ordinate is the differential pressure h, reference being made on diagram 1.

The period in which the calculator averages the record is from time t_1 to t_2, the average which equals with the arithmetic mean h_m, and the variation from this mean $\triangle h$, so that

$$h = h_m \pm \triangle h \qquad (1.)$$

$\triangle h$ being plus or minus as in over or under the h_m line.

The static pressure being considered as constant we can include it in the constant of the flow equation which is for the unity of time C, and the flow of gas in the differential time dt will be

$$dV = C\sqrt{h}\ dt \qquad (2.)$$

and integrating this in the period of $t_2 - t_1$

$$V_{12} = C\int_{t_1}^{t_2} \sqrt{h}\ dt \qquad (3.)$$

The calculator estimates the arithmetic mean:

$$hm = \frac{\int_{t_1}^{t_2} h\ dt}{t_2 - t_1}$$

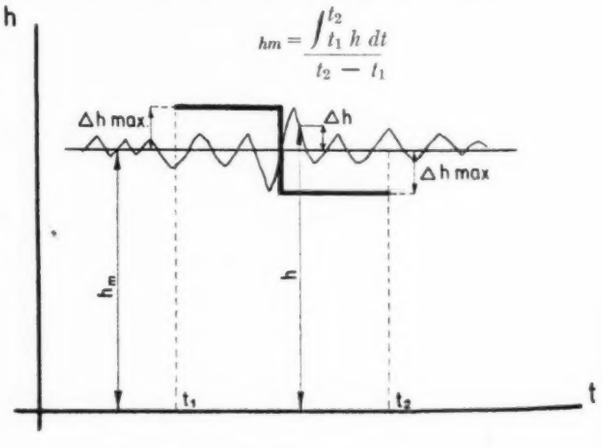

Diagram No 1

in Orifice culations

By EUGENE GUMAN,
Sonametan Company,
Mediasch, Roumania

and calculates with this the amount of flow, which will be

$$V_{12} = C\sqrt{h_m}\,(t_2 - t_1) \qquad (4.)$$

Substituting the value of h from equation (1.) in the equation (3.) we get

$$V_{12} = C\int_{t_1}^{t_2} \sqrt{h_m \pm \triangle h}\,dt = C\sqrt{h_m}\,.J \qquad (5.)$$

where J is for the value of the integral. Let the variable

$$\frac{\triangle h}{h_m} = X$$

this being in any case smaller then one, the integral can be developed in an infinite series

$$J = \int_{t_1}^{t_2} \sqrt{1 \pm x}\,dt = \int (1 \pm \frac{x}{2} - \frac{1}{2\,x\,4}x^2 \pm \frac{1x3}{2x4x6}x^3 - .....)\,dt$$

From the definition of the arithmetic mean results that the sum of the positive $\triangle h$ must equal the sum of the negative $\triangle h$, so in the above equation the members with compound sign will be eliminated and the integral will be

$$J = \int_{t_1}^{t_2} (1 - \frac{1}{2x4}x^2 - \frac{1x3x5}{2x4x6x8}x^4 - \frac{1x3x5x7x9}{2x4x6x8x10x12}x^6 \ldots)dt$$

The maximum possible error made by averaging in the period $t_2 - t_1$, will be committed if for every $\triangle h$ will be taken its maximum possible value, which is its maximum deviation from $\triangle h_m$ in the said period $\triangle\ h_{max}$ in diagram 1. indicated with dotted line. With

$$\frac{\triangle h_{max}}{h_m} = Xm$$

with integral will be

$$J = (t_2 - t_1) - (t_2 - t_1)\left(\frac{1}{2x4}x_m^2 + \frac{1x3x5}{2x4x6x8}x_m^4 + \ldots\right)$$

or with equation (5.) and substituting equation (4.).

$$V_{12} = V_{12}^{1}\left[1 - \left(\frac{1}{2x4}x_m^2 + \frac{1x3x5}{2x4x6x8}x_m^4 + \ldots.\right)\right]$$

and the error made by the averaging method reported to the erroneous value

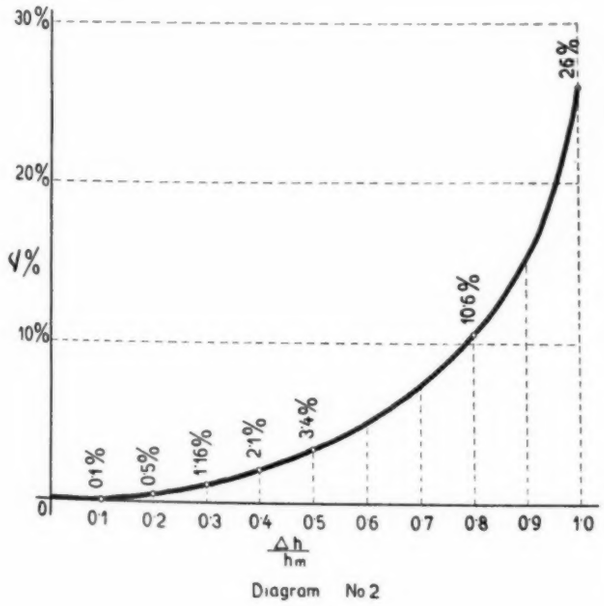

Diagram No 2

Fig. 106-A Jenkins Standard Bronze Globe Valve, Screwed. For 150 lbs. steam or 250 lbs. water working pressure.

EASILY TAKEN APART

and re-assembled repeatedly *without distorting the bonnet*

It is an easy job to unscrew the bonnet of this new Fig. 106-A Jenkins Standard Bronze Globe Valve. You can see why this is so. The generous hex faces offer a good grip for the wrench. The threads are clean cut, splendidly proportioned for smooth operation. The same superior quality of construction is to be noted in other parts of the design; in the extra deep stuffing box, greater number of spindle threads in contact with the bonnet, one-piece screw-over bonnet, slip-on stay-on disc holder, and Jenkins renewable composition disc. Fig. 106-A Valves are obtainable at your supply house. In writing us direct, ask for Form 141.

Jenkins Valves are always marked with the "Diamond"

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Report of Dearborn Representative I. L. Yetman:
"Inspected six-inch line coated with NO-OX-ID in 1927, both pipe and material look good. Also inspected eight-inch line coated with some black material same year. This will have to be reconditioned this Spring. Have hopes of getting this job."

Recommendations and estimates submitted gladly. Inquiries invited. Address us 310 South Michigan Avenue, Chicago; 205 E. 42nd Street, New York; 2454 Duncan St., Toronto

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PETROLEUM EQUIPMENT COMPANY of TEXAS
INCORPORATED
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$$\sqrt{} = \frac{V_{12} - V_{12}^{1}}{V_{12}^{1}} = -\left(\frac{1}{2x4} x \frac{2}{m} + \frac{1x3x5}{2x4x6x8} x \frac{4}{m} + \ldots.\right)$$

It will be noted that the error is always negative that is with the extension tables greater quantity is calculated than the real flow.

The convergency of this series can be easily demonstrated. The possible maximum value of the variation is

$$X_{max} = \frac{\triangle h_{max}}{h_m} = 1$$

and with this maximum possible error will be

$$v_{max} = -\left(\frac{1}{2x4} + \frac{1x3x5}{2x4x6x8} + \frac{1x3x5x7x9}{2x4x6x8x10x12} + \ldots.\right)$$

The n-th member of this series is

$$a_n = \frac{1x3x5\ldots(2_n - 3)}{2x4x6\ldots.2_n} = \tfrac{1}{2} \cdot \frac{1x3x5\ldots(^2_n - 3)}{1x2x3\ldots.(n-1)_n}$$

$$a_n = \tfrac{1}{2} \cdot \frac{(n+1)\ (_n+3)\ldots[_n+(_n-3)|}{2x4x6\ldots(n-2)_n} = \tfrac{1}{2}$$

$$\frac{(1+\frac{1}{n})\ (1+\frac{3}{n})\ldots(1+\frac{n-3}{n})}{2x4x6\ \ldots.\ (_n-2)}$$

or if every factor in the numerator will be substituted by its maximum possible value

$$a_n < \tfrac{1}{2} \cdot \frac{2x2x2\ldots.}{2x4x6\ldots(_n-2)} = \tfrac{1}{2} \cdot \frac{1}{(\frac{n}{2}-1)!} < \frac{1}{n!}$$

Which being the n-th member of the e series, thus the above series too must be convergent.

In diagram 2 the maximum possible error is plotted in percentual scale for the different values of Xm. The curve at the beginning is very slowly rising so as for $Xm = 0.5$ the maximum possible error is less than 3.5 percent, the probable error for a more oscillating curve being much smaller. From this point the curve is rising rapidly. If the variation from the arithmetic mean attains its maximum value, $Xm = 1$ the error is about 26 percent. Obviously this is a very extreme case. For example when the curve in the first half of the period runs on its highest value and in the second half of the period of the period on the zero line.

It must be accentuated that this error is in the maximun possible. The probable error can be estimated only by taking in consideration the form of the curve. Further one must bear in mind that this error is only that made by averaging the differential curve, the static pressure remaining constant. If the static pressure varies widely, too, the error can be much greater.

From this analysis results that it must be very careful with the application of the averaging method. Only when the maximum variation from the arithmetic mean does not exceed 30 percent will the error made by the extension method be less than one percent.

For eliminating the individual errors made by averaging the curve we introduced for such charts the hourly planimeter method. The radical planimeter is applicated in the known manner and read for every hour. From these readings the square roots are calculated and multiplied by the hourly square roots of the static pressure record, summed and multiplied by a complex co-efficient calculated from the units of differential and static pressure, the chart dimensions and from the orifice co-efficient. Naturally this method also requires some very tiresome calculations.

A theoretical correct result can be obtained only with the modern calculating machines. The writer has developed a very simple planimeter-like device by which a very satisfactory result can be obtained. By a mechanism the measuring wheel makes a track on a magnified square root curve so that the reading of the instrument is very accurate and is not lessened by the square root proportion.

FISHER BULLETIN No. 70, covering the Fisher Series 4000 Pilot-operated Pressure Regulators, a new development announced several months ago by The Fisher Governor Company, Marshalltown, Iowa. The pilot valve in this controller involves a new adoption of the Bourdon Tube principle and gives exceedingly sensitive control on all types of pressure installations.

LUNKENHEIMER OIL CUPS AND OILING DEVICES are illustrated and described in a new booklet issued by The Lunkenheimer Company, Cincinnati, Ohio.

SQUIRREL-CAGE MOTORS — Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo., has issued a loose-leaf bulletin page on polyphase squirrel-cage motors. Anyone interested in receiving this literature should ask for Bulletin 167, Part 7.

A SERIES OF STAINLESS AND HEAT-RESISTING STEEL PIPE AND TUBES is described in a new booklet of the National Tube Company, Pittsburgh, Pa. These tubular products are designed to meet the requirements of modern processes in manufacturing, chemical, oil refining and other industries.

SYMPOSIUM ON EFFECT OF TEMPERATURE ON THE PROPERTIES OF METALS is a fine 800-page book published jointly by the American Society for Testing Materials, Philadelphia, Pa., and the American Society of Mechanical Engineers, New York City. The book is composed of papers read at the joint meeting of the two societies and also carries the data compiled since 1924 by the Joint Research Committee.

THE TWENTY-FIRST EDITION of Williams Tools of Industry has been issued by J. H. Williams & Co. of Buffalo, N. Y. It is a very complete catalog of the widely adaptable Williams wrenches and tools.

RECORDING INSTRUMENTS, CD Type, for alternating and direct current, are fully described in Bulletin GEA-1061D of the General Electric Company, Schenectady, N. Y. Anyone interested in this subject will find this bulletin interesting and helpful.

THE CENTRAL FOUNDRY COMPANY, Graybar Building, New York City, has published a circular describing its Universal Dual-Lok Joint cast iron pipe and fittings, which is designed to meet present-day needs of a gas-tight joint under high pressures.

HAZARD WIRE ROPE COMPANY, Wilkes-Barre, Pa., is distributing a booklet known as "12 Reasons Why You Save Money With Lay-Set Preformed Wire Rope." This is by far the most comprehensive piece of literature on lay-set preformed rope that has been printed.

REX ROLLER CHAINS is the subject of a new book just produced by the Chain Belt Company, Milwaukee, Wis. Rex roller chain construction and features are discussed, in addition to many applications of various types.

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Conveying Heavy Liquids by Temperature Control

GEORGE W. PEW[1]

A PROBLEM of interest and at the same time one which has been solved in various ways with seldom a satisfactory result is that of the handling of viscous materials. In using the term viscous materials those materials are referred to whose viscosity varies with changes of temperature such as asphalts, oils, varnishes, and syrups.

These materials are usually—for ease of handling—conveyed in the liquid state through pipe systems. Sometimes the flow is by gravity, but the positive and more satisfactory manner is by motivating the liquid by a pump. In order to keep the material in process of conveyance in a liquid state, it is usually found necessary to heat the pipe-lines through which the material flows. The ways and means used to accomplish this are almost as varied as are the industries in which the problem arises. Make-shift arrangements have been the rule rather than the exception and many lines have been installed which to this date remain just so many feet of pipe and have positively failed to function as conveyance medium for the viscous substance they were intended to carry.

The various installations and early attempts at solving a troublesome problem all lead to the development of an efficient and modern system. The steps in the development of such a system are of interest to those concerned with the handling of such materials.

Probably the first and at the same time the least satisfactory method of handling viscous materials through pipe was that of heating the material at the point of intake and allowing it to either flow by gravity or be pumped through a pipe line until the initial heat carried by the liquid was dissipated to such an extent that reheating was again necessary. After each period of operation of such a line it must be blown out with compressed air, in order to prevent its being left full of solidified product which would necessitate heating the whole line by fire or other means before pumping could be resumed.

In many plants the auxiliary line system has been used successfully, although it is far from an efficient one. This consists of running a small auxiliary steam line directly under the product line. Through this smaller line the heating medium flowed and by radiation the temperature of the product line was raised. The two lines were of course enclosed with insulating material. This system probably constituted the first system wherein the material conveyed was heated continuously all along the line of travel.

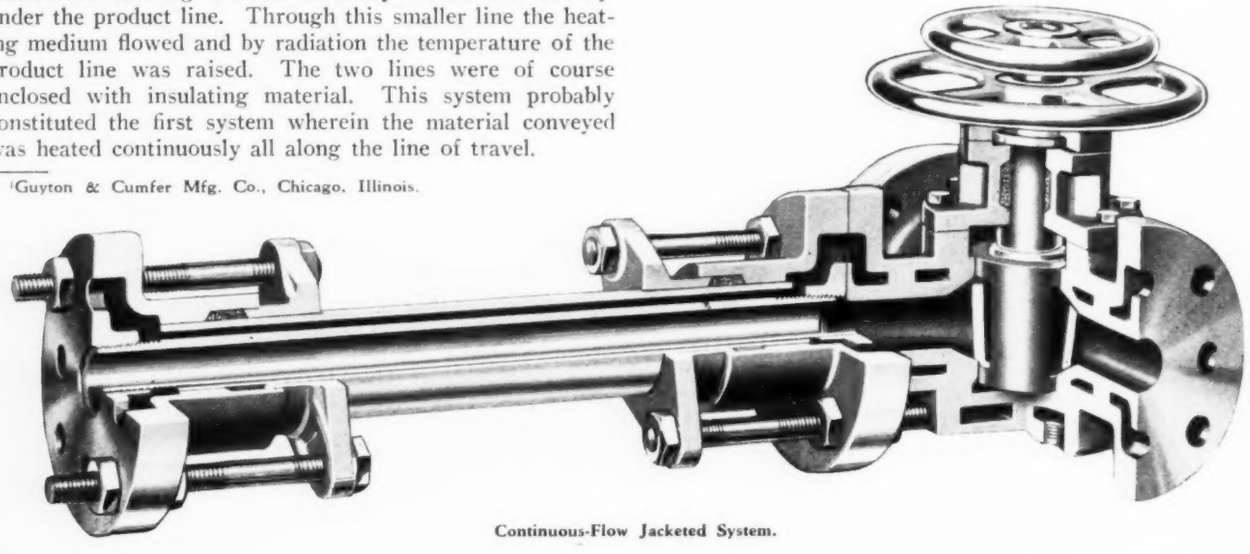
As can be easily seen, such a system was a slow one to heat up and get into operation and inefficient in the extreme even at best.

Another installation that followed and was a great improvement over all previous attempts along this line came when the small auxiliary line was placed inside of the product line. Now the heat transfer was more efficient as it took place by radiation and direct contact as the product flowed about the inner line conveying the heating medium. In this arrangement, however, leakage of the heating medium in case such occurred was well-nigh impossible to find. Another disadvantage of this system was that the medium to be heated was at all times in contact with the coldest part of the conveying pipe. The chief objection to this system, however, lay in the fact that the useful cross-section of the product line was decreased by the cross-sectional area of the heating medium pipe and that the frictional resistance to the flow of the product was increased in proportion to the outside area of the inner heating medium pipe line.

The next system coming into quite general use and which is still used to some extent was the by-passed jacketed system. This system in its many stages of development was to be the final experiment before the modern continuous-flow full jacketed system was introduced. This system, however, was a difficult one to keep in condition due to improper provision for expansion and also to the reduction in area of the heating medium conduit at points of by-passing.

The by-passed system may be fabricated in many ways, in all of which the principle of by-passing the heating medium either around the intermediate fittings or around the flanges of the intermediate fittings is the characteristic feature.

Many systems of by-passed jacketed lines make use of specially cast pipe. The pipe consists of an inner section surrounded by an annular space for the heating medium which keeps the product at the desired temperature. These pipes are made up in various standard lengths, closed at



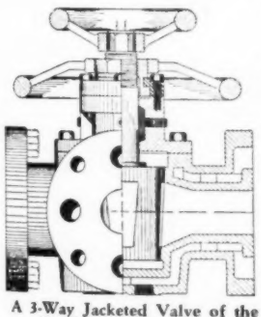
Continuous-Flow Jacketed System.

[1]Guyton & Cumfer Mfg. Co., Chicago, Illinois.

both ends about the heating medium passage, and fitted with pipe flanges. The outer shell must then be taped near each flange and a series of small standard pipe fittings used in passing the heating medium around the connecting flanges and from one pipe section to another. Drain traps and an auxiliary wet return must also be supplied if the line is to operate at its maximum efficiency.

A still more popular by-passed system of years gone by and still lingering in many industrial plants is one using a standard size inner product pipe and another standard pipe of larger size as a jacketing pipe carrying the heating medium. Both these pipes are screwed into special flanges at each end. By use of these flanges the jacketing pipe is blanked off, while an opening is of course provided for the continuous travel of the product from one pipe section to another. Here, too, the heating medium is by-passed around the flanges as previous described. It is at once apparent that in such systems the difference in expansion between the product pipe and jacket pipe—due to differences of and changing of temperatures—cannot be satisfactorily taken care of. Even the introduction of expansion joints leaves pipe sections without proper provision for this all-important problem. Some by-passed installations are made with pipe welded into the flanges. The type of installation further decreases the flexibility of the lines, and also makes repair and inspection of the line an expensive and laborious task.

One of the longest jacketed lines in the United States has been installed for some time at the middle-western refinery of one of the largest oil companies in the world. The by-passed jacketed pipe system was used. Sections of double pipe (product and jacket line) were built up in the desired lengths by welding the pipe into the end flanges. Standard pipe fittings and valves were then used throughout the system and the heating medium by-passed around these fittings through a series of small pipe fittings. Each standard fitting acted as a cold spot in an otherwise hot line and so a bucket was hung under each fitting and at every start-up the bucket was filled with waste and oil and a fire started to warm up the numerous troublesome spots throughout the line. All these open fires were tolerated where smoking was prohibited due to the fire hazard. Of late this company has been installing numerous three-way valves as shown in the illustration and eliminating both trouble and fire hazard.



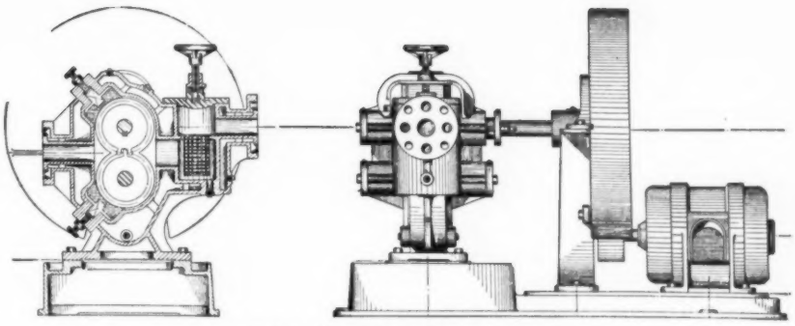
A 3-Way Jacketed Valve of the Continuous-Flow Type.

The valve mentioned and the other equipment shown in the illustrations are the latest development in equipment for the handling of viscous materials and the system is called the continuous-flow jacketed system.

This system was devised and developed for the handling of asphalts and heavy oils. This system was not placed upon the market in its present state of perfection.

Here was the result of observation of all other systems, of continued experimentations and trial until the goal of a continuous-flowing jacketed line, which successfully eliminated by-passing around joints and fittings was attained. Also it eliminated the use of special pipe sections, welding, and auxiliary wet return lines, and made ample and logical provision for expansion in every pipe section.

The continuous-flow jacketed equipment is found in use throughout a wide range of industry. In refineries where



Jacketed Pump With Base and Drive.

asphalts and paraffines are handled such equipment is doing a great deal toward efficient and economic production in providing a handling system free from the usual costly delays due to frozen and plugged lines.

One of the larger zinc works recently installed continuous-flow jacketed lines for the handling of sulphur from melters to the burners at the Heireshoff Roasting Furnace. Such an installation handling a troublesome material is invaluable and is but one example of the many possible applications of this little known labor-saving equipment.

The oil refineries—the oil industry being highly competitive and therefore necessarily progressive—are not only equipping their inter-plant transport lines with such equipment, but installing large manifolds and special jacketed equipment calling for specialized design and engineering.

The introduction of the continuous-flow jacketed system seems to have awakened industry to the possibility of effectively handling viscous materials in an efficient manner so as to aid in production and product control.

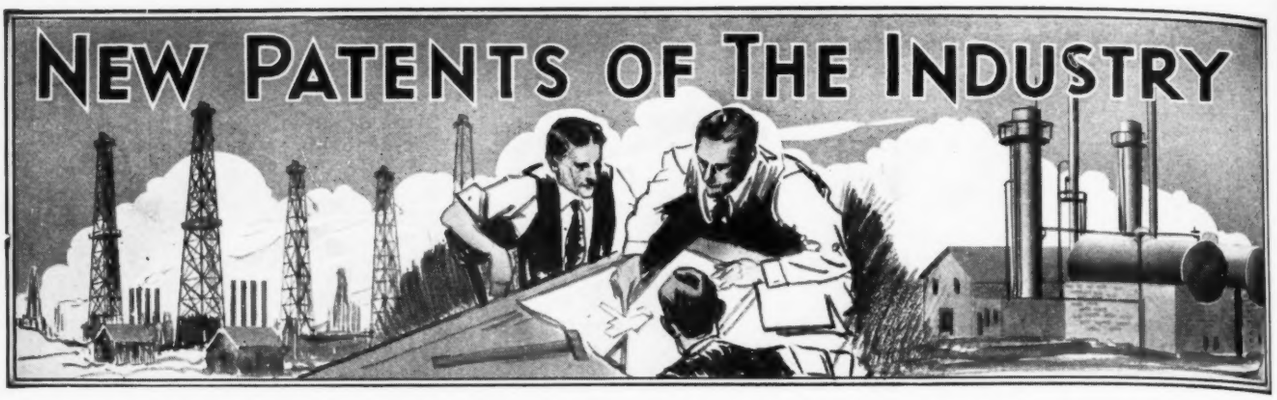
In the continuous jacketed system the product is conveyed through an inner pipe and any number of connecting fittings the installation may make necessary. The heating medium, on the other hand, flows in the annular space between the product pipe (standard section) and the outer of jacketing pipe (also standard section, but larger so as to enclose the product pipe). At every fitting and flange the heating medium is carried directly through the fitting in an annular space designed for this purpose and then passes through connecting port-holes in the flanges of the fittings. Thus, there are no cold spots in the line, and the entire line can be heated by turning the heating medium into the jacket-line. There is no slow warming-up process, such as is necessary in the other systems.

The couplings used in this system are designed so that the product pipe is screwed into place while the jacketing pipe is floated between fixed stops, as shown in the illustration. The outer or jacket pipe is provided with a packing gland to keep the system tight against any pressure desired. The flexibility, and ease of erection, testing, maintenance, and repair in such a system are at once apparent.

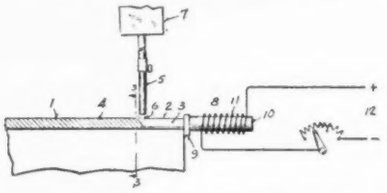
In spite of the obvious outstanding advantages of the modern continuous-flow jacketed system, the initial cost, as well as the maintenance, is in almost all cases less than that of other systems.

Completely jacketed gear pumps with jacketed strainer baskets cast integral with pump are in use with this system having flanges of the continuous-flow design.

In looking over the efforts made in the development of equipment for handling materials whose liquid characteristics are largely dependent on temperature control it is seen that a logical and scientific line of equipment is now serving the process industries and its further adaptation to special requirements is a matter only of realization of actual resultant economies and benefits brought about through proper handling and product control.

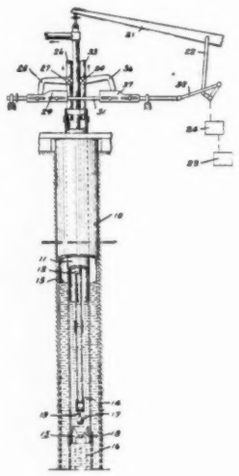


1,840,330. APPARATUS FOR ELECTRIC ARC WELDING PIPE. ARTHUR W. PRIEBE, Milwaukee, Wis., assignor to A. O. Smith Corporation of Milwaukee, Wis., a Corporation of New York. Filed Aug. 26, 1929. Serial No. 388,366. 3 Claims. (Cl. 219—8.)



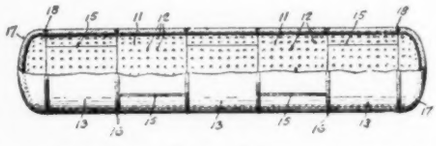
1. In an apparatus for electric arc welding tubular articles, an electro-magnetic member seated against an end of the tubular article adjacent the seam to be welded to correctively alter the magnetic flux conditions at the end of the seam, and means for controlling the magnetic strength of said member.

1,840,646. OIL WELL PUMP. HAROLD F. WATKINS, Oakland, Calif., assignor to Watkins Intermitting Pump Co., San Francisco, Calif., a Corporation of California. Filed May 15, 1928. Serial No. 278,014. 5 Claims. (Cl. 103—234.)



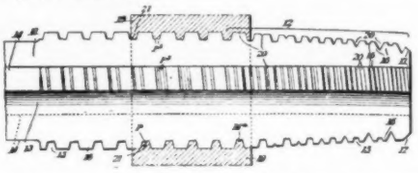
1. In an oil well pump, oil and gas pipe strings extending into the well, said gas pipe communicating with the oil pipe below the normal level of the oil in the well, a valve within the well serving to control flow of oil from the well into the gas pipe, said valve being opened and closed upon cyclic movement of one of said pipes, mechanism located at the surface of the well for cyclically moving said one pipe, and means functioning automatically upon cyclic movement of said one pipe for introducing intermittent charges of gas into the gas pipe from the surface of the well in time with said cyclic movements, each charge being introduced while said valve is closed to form an upwardly expanding pneumatic piston in the oil pipe.

1,840,305. OIL REFINING STILL. ORRIN E. ANDRUS and SUNE HERMANSON, Milwaukee, Wis., assignors to A. O. Smith Corporation, Milwaukee, Wis., a Corporation of New York. Filed July 13, 1928. Serial No. 292,376. 3 Claims. (Cl. 219—10.)



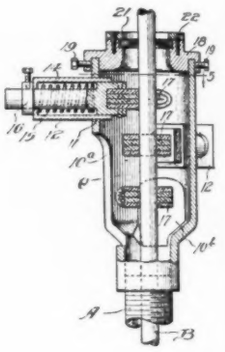
1. A method of making a thick walled vessel normally subjected to corrosive action which comprises applying a thin sheet of corrosion resistant metal to the surface of a thick steel base plate, said sheet having a thickness less than the thickness of said steel plate and having a yield point not less than that of the steel plate, uniting by resistance welding distributed contacting portions of the sheet and plate to form a composite plate having a surface of corrosion resistant metal, the relative thickness of said plate and sheet causing the jointure between said sheet and plate to be offset from the medial longitudinal plane of the composite plate, heating a plurality of composite plates so lined to a rolling temperature, bending said heated plates into sections capable of being assembled into a cylindrical body with the liner disposed on the interior surface thereof, assembling and welding said sections edge to edge to complete the body of the vessel, and welding end sections to said body to complete the vessel.

1,846,501. THREAD CUTTING TOOL. ROBERT THOMSON, Newark, N. J., assignor to Dardelet Threadlock Corporation, New York, N. Y., a Corporation of Delaware. Filed May 23, 1929. Serial No. 365,387. 6 Claims. (Cl. 10—141.)



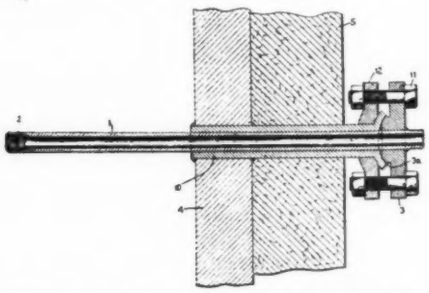
1. A screw thread cutting tap having lands with tapered portions at the entering end of the tap followed by non-tapenered portions at the inner ends of the lands, both the tapered and non-tapered portions of the lands being cut by a helical thread groove leaving interdental portions corresponding with the crest profile of the thread designed to be cut on the inner parts of the non-tapered portions of the lands, a series of non-cutting interdental portions on the lands extending a substantial distance inward from the entering end of the tap, and an intermediate series of thread crest profile cutting interdental portions having cutting edge portions progressively receding from the axial line of the tap from the second mentioned series of interdental portions to the first mentioned series of interdental portions.

1,840,334. CLEANER FOR SUCKER RODS AND THE LIKE. ARTHUR M. SCHUSTER, Midwest, Wyo. Filed Jan. 18, 1929. Serial No. 333,434. 6 Claims. (Cl. 166—14.)



1. In a sucker rod cleaner, the combination of a hollow frame, and a plurality of vertically spaced yieldable scraper elements slidably mounted in said frame and projecting inwardly thereinto at different angles about the axis of the rod, said frame having a horizontal ledge about the top adapted to support a rod-holding tool.

1,847,059. THERMOCOUPLE WELL. JOHN J. BESHARA, Port Arthur, Tex., assignor to The Texas Company, New York, N. Y., a Corporation of Delaware. Filed Jan. 8, 1930. Serial No. 419,299. 2 Claims. (Cl. 136—4.)



1. A thermocouple well comprising a tubular member having a closed end adapted to protrude into a treating zone and an open end adapted to protrude outside thereof containing a thermocouple, a flange attached to the tubular member near its open end, a sleeve partially inclosing the tubular member having one end adapted to be secured into means inclosing the treating zone and the other end flared and protruding outwardly, a slip flange on the sleeve adapted to co-operate with its flared end and the flange on the tubular member and bolts for drawing the two flanges together thereby securing the thermocouple well rigidly in the sleeve and thereby into the treating zone.